WORLD CROPS

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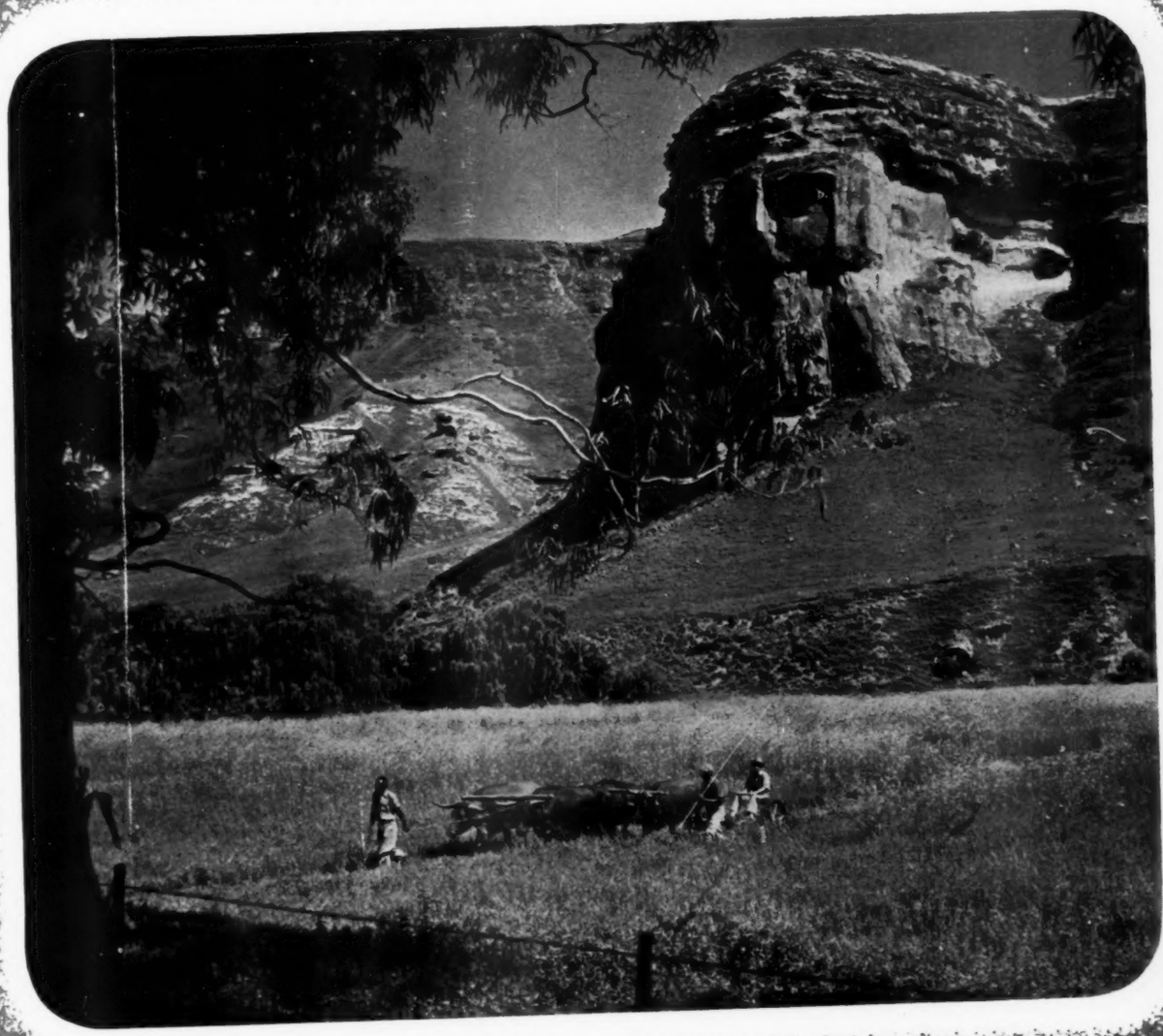

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NOVEMBER 1949

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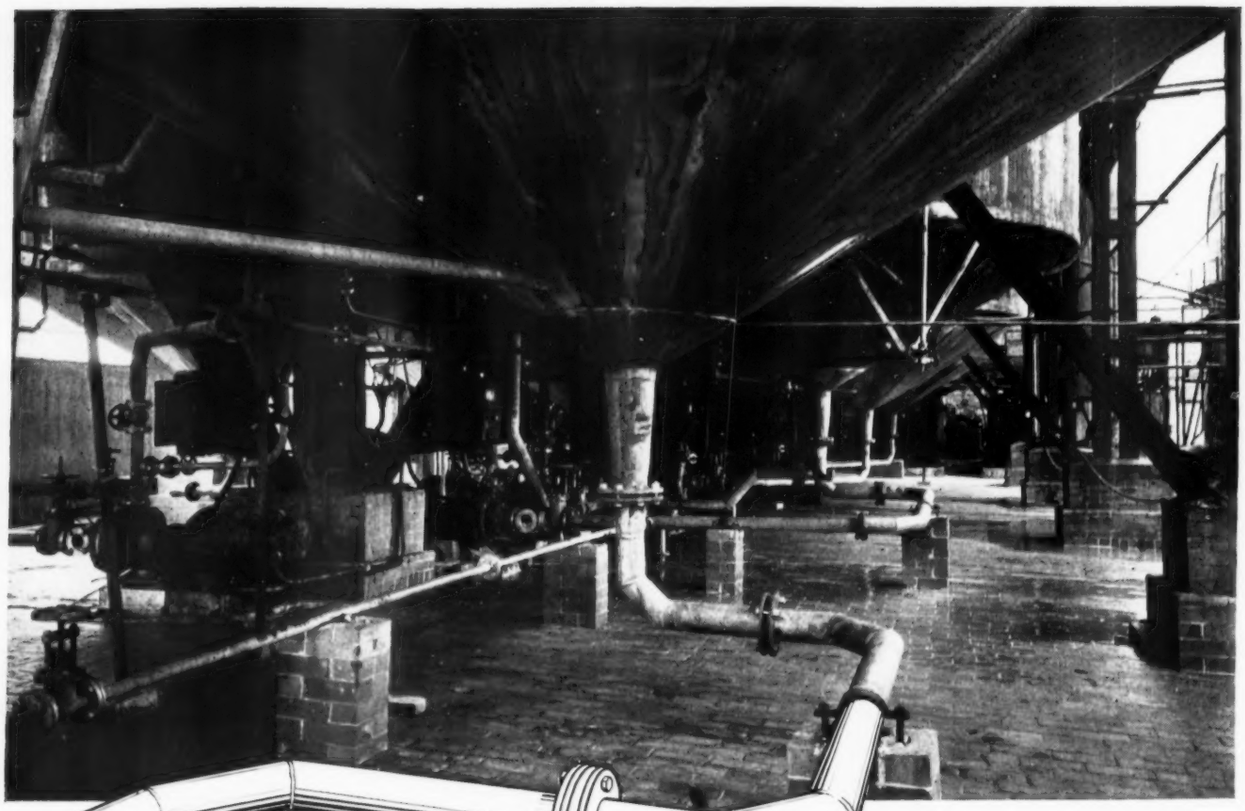

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WORLD CROPS

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THIS MONTH'S COVER

A scene of wild and rugged beauty in the Golden Gate District of Bethlehem in the Orange Free State, S.A. In the foreground a machine drawn by a team of oxen is engaged in harvesting a crop of lucerne on the level land, but note the eroded and overgrazed slopes above. *Photo: South African Railways*

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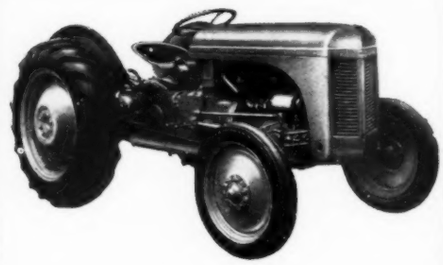
—HARRY FERGUSON



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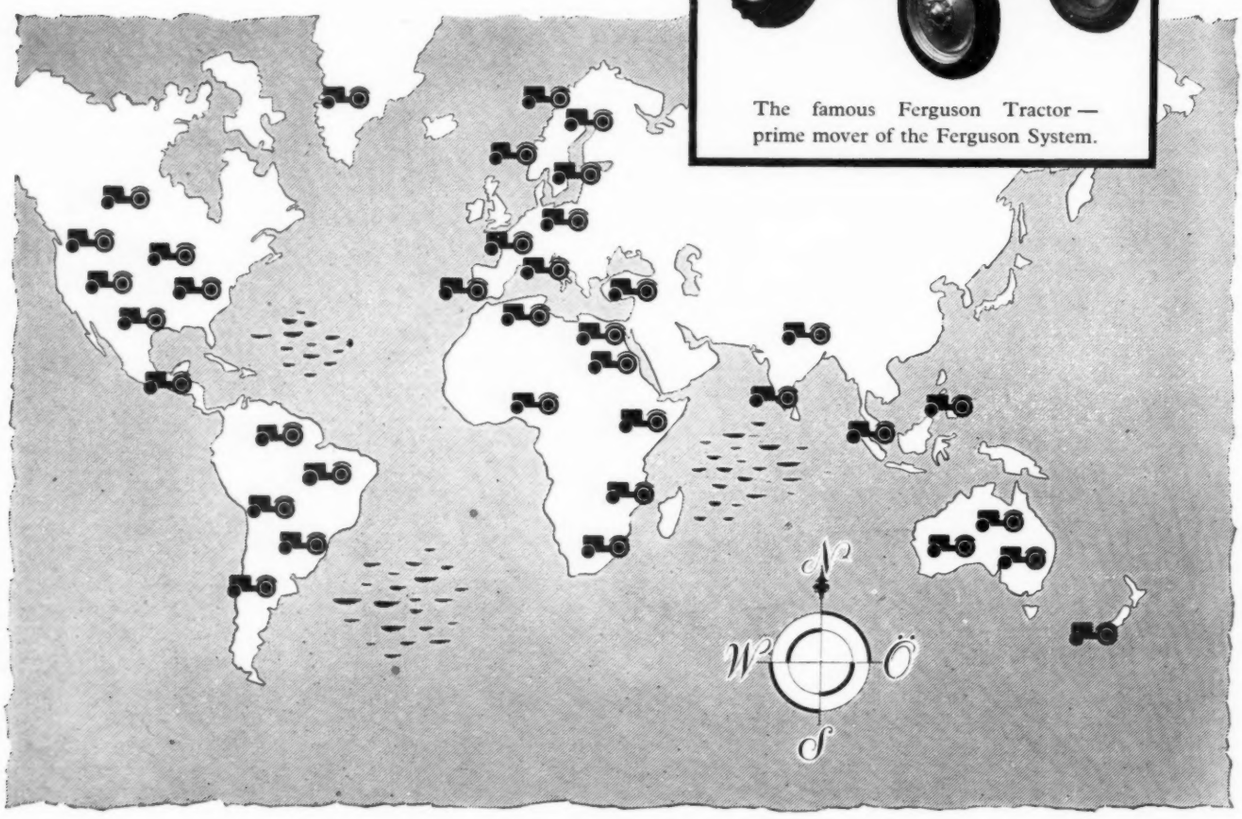

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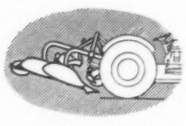
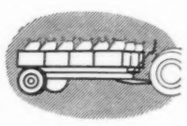
Spike Tooth Harrow



2-Furrow Plough



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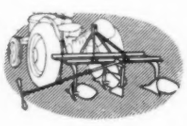
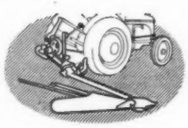


Ridger



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Editorial Comment

Agriculture and devaluation

IN the midst of the political uproar which has followed the devaluation, or, as it has been termed more euphemistically, revaluation of the pound sterling, it is somewhat surprising that so little has so far been said of the probable effects of this decision upon agricultural industry, not only in Great Britain, but also throughout the world, more particularly in regard to the production of food, but also in respect of raw materials for industry.

One of the major effects of the war has been to cause a considerable reorientation of food production from the Eastern to the Western Hemisphere. This is clearly shown by figures given in the articles on world cereals currently appearing in this journal; for example, exports of rice from the United States and Brazil, which before the war were negligible, together now account for 27% of the world total of exports.

Devaluation of many currencies amounting to something over 30% in relation to the dollar accordingly means that, in order to maintain their imports at something approaching the existing level, food-importing countries must increase their exports of raw materials and manufactured goods by a considerable amount, and this in turn must depend on the willingness and ability of the countries of the dollar *bloc* to accept them.

In the circumstances it seems not improbable that, whether they like it or not, countries markedly dependent on imported food will be forced to turn their attention to the production of increasing quantities of home-grown food, supported by a policy of buying as much as possible from non-dollar sources.

In a recent letter to *The Times* newspaper it was pointed out that, as the result of devaluation, for the first time for 100 years Britain can now produce wheat more cheaply than she can import it, notwithstanding the unnecessarily high costs of production, and that this also applies to other cereals and probably to meat. The letter goes on to point out that for these reasons it is vitally necessary for Britain to increase her agricultural output and that the fate of the nation lies very largely in the farmers' hands.

For other countries within the sterling area the same holds true ; territories which normally produce the major portion of their food requirements will feel the effects least, but those which have evolved an economy dependent in a major degree on exports are bound, it would seem, to suffer. In some of the British Colonial areas, for example, in the African territories, which have always been self-sufficient in food, the effect may not be so disastrous, although the existing level of production per unit area or per unit of labour employed is very low, but in others, such as Malaya, the West Indies, Mauritius and Fiji, which are mainly dependent on export staples, such as rubber, sugar, copra and the like, the position may well prove exceedingly difficult.

Actually the situation that seems likely to arise is no new one ; it had a forerunner in the world depression of the 1930s, when countries such as Indonesia, which, under Dutch rule, always laid stress on the need for as great a degree as possible of self-sufficiency in the staple food—rice—suffered far less than did the neighbouring Malay Peninsula, where, under British rule, the emphasis had always been on production of rubber for export.

The 1944 Conference on Food and Agriculture at Hot Springs, U.S.A., the forerunner of the Food and Agricultural Organisation, made it quite plain that it was the duty of every country to produce within its own borders as much as possible of the food it needed. The present disjointed economic situation only underlines the need for this policy.

So long as mankind's political immaturity precludes the formation of a mondial economy in which production and trade will be regulated in all directions in accordance with human needs, increases in food production in each country are essential. No amount of fiddling with exchange rates will alter this fact.

Ensilage

ON other pages we reproduce excerpts from an article which recently appeared in the official journal, *Farming in South Africa*, on crops suitable for ensiling under South African conditions. Ensiling has been regularly practised for many years as part of normal farming routine in the U.S.A., Canada and some of the countries of Northern Europe. Its extension to Great Britain and some of the other countries of the British Commonwealth is more recent and, indeed, it is only within the last few years that it has become part of established farming practice in Great Britain and some of the Dominions, while in the Colonial Dependencies it has so far achieved little popularity.

It has become recognised that grass silage is, with the possible exception of dried grass, the most important feed capable of being produced on the farm; its earlier lack of popularity was due to

lack of understanding of the principles which must be observed if it is to be made successfully. The controlling factor is the acidity in terms of lactic acid and the aim should be to induce lactic fermentation, and on this account material rich in carbohydrates is to be preferred, *e.g.* grasses and similar material, when it is richest in fermentable carbohydrates. With material low in carbohydrates it may be necessary to add carbohydrate-containing material, such as molasses, ground corn, sugar beet pulp, potatoes, etc.

A recent development which has obtained popularity in Norway and is being tried in this country is to shred the material by a specially designed machine (*see page* 124) which ensures that the plant juices are thoroughly expressed and mingled with the mass of material in the stack, thereby ensuring that the carbohydrates contained in the plant juice are thoroughly incorporated. Formerly ensiling was thought to involve the construction of stave or masonry tower silos or the digging of deep pits and their lining with acid-resistant material, which added greatly to the initial cost and at the same time did not always ensure successful results ; this is avoided by modern practice, which favours making the silage in long shallow pits in which the silage is stacked as the material is cut, the necessary compaction being ensured by passing a tractor over the heap as it grows, the whole being capped with earth when finished, which provides the necessary protective covering.

The possibility of the extension of ensiling to the warmer tropical countries, where, especially in regions with a long dry season, the provision of feed for stock is often an acute problem, merits careful examination; under such conditions some form of moist succulent feed can be of inestimable value.

In these circumstances the experience recorded from South Africa is of interest, since it affords an indication of what may be possible in regions where climates are hotter and conditions even more rigorous and exacting.

West African cocoa—controversies and cures

DURING the recent conference in London on the cocoa industry a report of which appears elsewhere in this issue, there was a sharp exchange between Lord Rennell and Mr. Creech Jones, the Colonial Secretary, concerning the responsibility of the Government for the spread of Swollen Shoot disease which is seriously threatening the industry.

Lord Rennell claimed that the present desperate situation in the Gold Coast was largely the result of slackness on the part of the Government. Political considerations and the outcry of subversive and ill-informed elements of the community in the Gold Coast had been allowed to outweigh the need for enforcing the only known means of checking the disease; there had been, in any case, insufficient provision of staff to enable them to be carried out effectively once cutting out was resumed. In consequence ' the cocoa industry of the Gold Coast is within measurable distance of extinction unless remedies are applied at once.'

In his reply to these accusations, Mr. Creech Jones defended the Government's tardiness on two grounds. Firstly, he said, there would have been serious danger to life and property if the cutting out campaign had not been suspended for a time after the Accra riots. Secondly, time was needed for independent confirmation that cutting out was indeed the only remedy. He agreed that the delay was unfortunate, but it was the lesser of two evils. Now that the necessity for cutting out had been established as the only possible course, the Gold Coast Government were determined to carry on the campaign with the utmost possible vigour. Good progress was now being made and there were now far more applications for cutting out than it was possible to handle with the labour and staff available, but staff was being increased as fast as circumstances allowed.

To us it seems inescapable that there is little to be gained by polemics ; it is satisfactory at least to know that the matter is being handled vigorously and the main point is to get on with the job with all possible speed. There is, however, little doubt that, whatever may be the cogency of the political considerations, the spread of the disease was accelerated by the delay of many months when cutting out operations were suspended on the recommendation of the Commission of Enquiry into the Accra riots, and pending the report of the three independent foreign experts appointed by the Colonial Secretary to verify the findings of the British scientists. It is well to remember that the disease spreads in geometric progression as attacks mass up, and that its rate of spread cannot be influenced or halted by political considerations, no matter how cogent they are, or by the recommendations of a commission, no matter how august its composition.

The implied distrust in the recommendations of British scientists also seems somewhat regrettable, notwithstanding that they were subsequently emphatically endorsed by the visiting committee of three foreign scientists. It really does not enhance British prestige when the Government shows so clearly the doubts it entertains concerning the reliability of its own scientific workers.

Apart from this, however, the point which does not appear to have been grasped is that the structure of the cocoa industry, comprising probably over a million smallholdings all independently owned and scattered over many thousands of square miles of African jungle, and often without adequate lines of communication, is about the most unsuitable that

could be conceived for the control of a disease problem such as this. For effective control, each of these plots should be visited not once, but several times a year, and this would involve the employment of almost an army corps of inspectors. If the structure of the industry could be altered and plantations confined to large blocks with adequate access and subject to overall control, the problem would be greatly simplified and costs of control reduced.

The long-range problem confronting the Administration is undoubtedly the devising and introduction of such a structure to the cocoa industry, and we believe that the survival of the industry is largely dependent on its solution.

The Great Virus Mystery

THE plight of the cocoa industry in West Africa prompts some reflections on virus diseases. Since the first demonstration at the end of the last century that filterable viruses are the cause of diseases in plants and animals the part they play in limiting crop production has become ever more and more evident. Today their name is almost legion and the plants they attack include such diversified crops as potatoes, tobacco, tomatoes, sugar cane, maize, cocoa, peaches, tea, and many others. Additions to their numbers are constantly being recorded; experience in West Africa shows that new virus forms may lurk unseen and undetected like bandits in the natural vegetation ready to infect and destroy a susceptible crop when it is introduced into cultivation. Transmitted mostly, but not invariably, by insect vectors, the identity of which is oft-times not easy to ascertain, and producing initial symptoms often difficult to recognise, it is small wonder that they constitute one of the most baffling problems ever presented to the plant pathologist and the cultivator. It may, indeed, be said that the story of virus diseases rivals in interest the most bizarre of the detective romances which compete so vigorously for popular favour, and the investigator is called upon to display an acumen and ingenuity rivalling the legendary feats of Sherlock Holmes and Hercule Poirot.

Many of the secret villainies of the viruses have already been unmasked and part of the tangled skein of their nature and their ways of working has been unravelled, but much is still unknown. We know, for example that they are definite chemical compounds ; some even have been crystallised and with the aid of the electron microscope scientists have been able to glimpse their molecular appearance and structure. We know, moreover, that in plant and animal tissues these apparently lifeless substances can increase and multiply in manner similar to living organisms. When the tangle is unravelled finally it may well be that we may find ourselves advanced a stage further towards the solution of the great central mystery of the nature of life itself.

Among the latest recruits to this desperate band of viruses is the Sudden Death disease of the clove tree, which has for many years puzzled scientists, and which now threatens with extinction the clove industry of Zanzibar and Pemba, upon which the economy of that Protectorate rests. After years of investigation it is now accepted that the condition must be due to a virus, since all other possible causes have been eliminated. In the words of the immortal Sherlock to his amiable stooge 'Eliminate all other possibilities, my dear Watson, and the one which remains, however improbable, must be the truth.' In this case the only alternative is a virus disease which presents no recognisable symptoms until shortly before the death of the tree.

What of the outlook ? Today the only accepted remedy is the ruthless one of roguing or cutting out diseased plants and those in immediate contact with them ; not, perhaps, so serious a matter when it is a question of dealing with crops like potatoes or tobacco, which mature in a few months, but extremely serious in the case of tree crops, like cocoa or cloves, which take a number of years to reach the bearing stage.

There may, however, be a ray of hope; just as in the case of some virus diseases in man or animals, for example, yellow fever or rinderpest, inoculation with attenuated strains has been found to confer temporary immunity, so there are indications that inoculation of plants with non-virulent strains of viruses may provide a measure of protection.

Moreover, the biochemist is now beginning to find substances which can be used in their control. For example, the work of Horsfall and his colleagues at the Connecticut Agricultural Station reported at the recent Crop Protection Conference supports the belief that chemotherapeutical substances could be successfully employed in treating virus infections. It is too early to be sanguine, but one way and another there are some definite signs that at long last we may be on the road to the solution of the Great Virus Mystery.

Selling soil conservation

THE United States *par excellence* is the land of spectacular achievement ; everything is done there more or less on the grand scale, and this applies, not only to desirable things, but also on occasion to matters that are the reverse. In this particular case we are thinking of the great problem of soil erosion. Owing to the rapidity with which the development of their unused lands was undertaken, soil erosion assumed proportions never paralleled in other countries. Soil erosion is, of course, essentially a symptom of wrong land use, and it is probably not too much to say that never in

the history of the world has more land been worse used in a shorter space of time than was once the case in the U.S.A.

But with the recognition of the dangers has come prompt and effective remedial action. The enactment of the Federal Soil Conservation Act in 1935, followed by the State Soil Conservation laws and the establishment of the vast Federal and State conservation services has revolutionised the position and today every one of the 48 states of the Union has enacted soil conservation laws, while upwards of 2,000 soil conservation districts have been established.

In adapting and modifying soil conservation measures to suit particular conditions and in securing their adoption by the communities affected, the Americans have led the world, while all the resources and ingenuity of the fertile American mind have been enlisted in putting over to the farmer and the public the need for incorporating conservation measures into the farming system.

Their methods have been followed in many countries; for example, the Union of South Africa in 1946 enacted legislation largely based upon the American model and incorporating the concept of the soil conservation district, of which a number are now in existence.

Among the more recent devices adopted in America is what have been termed one-day demonstrations. In these a concentrated effort is made to carry out necessary conservation measures on a selected property in the short space of a single day. Resources are mobilised to the fullest possible extent and during the course of the proceedings the whole gamut of operation necessary to rehabilitate the farm and to place it in a position to be worked along sound lines in the future are carried out, including the realignment of cultivation, the construction of bunds, the construction of dams, the movement and erection of buildings, the planting of protective belts and so forth, all in accordance with plans prepared on the basis of previously conducted surveys. The occasion is widely publicised beforehand and the agricultural community turns out in thousands to witness the demonstration.

It has been stated that such demonstrations are meeting with considerable success. It is, of course, necessary to ensure that the operations carried out will be followed up and maintained by the owner of the property, but provision to ensure this exists in the legislation. Such demonstrations certainly possess the merit of compressing into a short space operations which normally might take months to accomplish, and the spectacular appeal is undoubted.

Whether such methods could successfully be adapted to other conditions remains to be seen, but there does not seem to be any particular reason why they should not meet with success where circumstances approximate to those which prevail in those parts of the U.S.A. where they have been applied.

Phosphate fixation

THE mode of action of phosphatic fertilisers is one of those teasing conundrums which continue to exercise the minds of soil and fertiliser specialists.

It is generally agreed that much of the phosphorus which resides in the soil is normally unavailable to the plant, and when phosphatic fertilisers are applied to the soil a considerable amount reverts to the insoluble form and so cannot be used by the plant. Nevertheless, the advantages which accrue from phosphatic dressings in appropriate conditions are undoubted.

It is, moreover, agreed that phosphatic fertilisers are of most benefit when given in the early stages of the crop growth, and that in the later stages the plant becomes dependent on the phosphorus naturally existing in the soil rather than on that supplied by fertiliser. The matter is discussed in an article by Mr. D. P. Hopkins in this issue of WORLD CROPS and was also touched upon by Dr. Scott Russell in his article on radioactive tracers in agricultural research in our October issue.

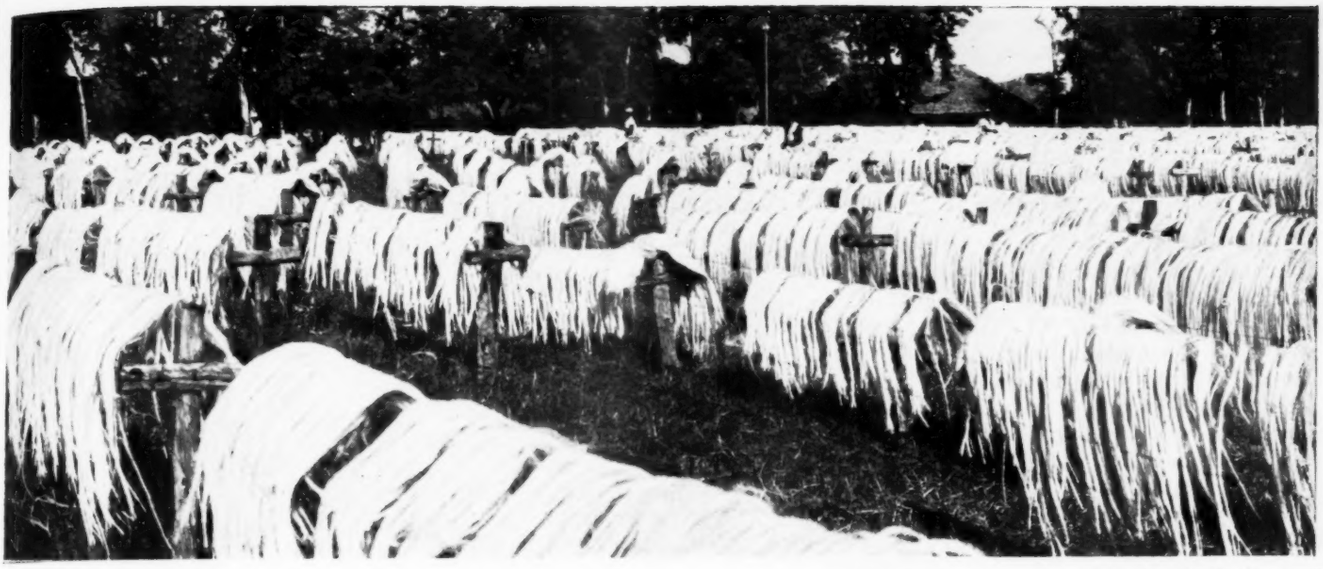
While there is agreement on this, there is, however, some divergence as to the function of the fertiliser. Mr. Hopkins suggests that the function of a phosphatic fertiliser is to add to the top soil supplies of phosphate which are able to pass readily into the soil solution and thus augment the soil's rate of supply and that the effect of the early intake is to enable the plant to take up more phosphorus from the soil than would be the case had not the fertiliser phosphorus been applied previously.

Dr. Russell, on the other hand, considers that the effect may not be entirely the result of the absorption of the fertiliser, but rather to more active root development at an early stage which may later result in the plant developing a root system which more efficiently absorbs the soil phosphate.

The distinction is a nice one and, as both authors suggest, it may be resolved by the use of radioactive tracer elements.

It may well be, also, that the same technique will throw light on the problem of the reversion of phosphates in the soil, of which the causes are still to an extent conjectural.

If as a result of investigations on these and similar lines our knowledge of the fate of phosphates in the plant and in the soil can be increased, it may, as Mr. Hopkins suggests, lead to the devising of more effective phosphatic fertilisers which are not so liable to reversion, and so pave the way for the fuller utilisation of this essential element.



Sisal in the drying yard

The Sisal Industry of British East Africa

Two world wars gave a considerable impetus to the sisal industry of Tanganyika and Kenya, and British East Africa is today by far the most important source of hard fibres.

The resumption of sisal production in Indonesia and the revival of the manila hemp industry will, however, increase the competition which the industry has to face.

In these circumstances East African producers are doing much to improve cultivation methods in order to lower production costs and are also seeking outlets for the waste by-products of the industry.

SINCE the last war British East Africa has become the largest and most important producer of hard fibres. This class of fibres is used mainly for the production of ropes, cordage and twines ; the two chief members are sisal and manila hemp, but other fibres of less importance included in it are New Zealand Hemp (*Phormium tenax*), Mauritius Hemp (*Furcroea gigantea*), various species of *Sanseviera* and some others.

Prior to the war about one-third of the total production of sisal came from East Africa, one-third from Java and Sumatra in the Indonesian region, and the remainder being accounted for by production of the closely allied, but not identical, product henequen* in Mexico. Manila hemp, of which the total pre-war production varied from about one-third to one-half that of sisal, was mainly produced in the Philippine Islands, with smaller quantities in Borneo.

In East Africa by far the largest quantities came from Tanganyika and Kenya, but sisal plantations on some scale have been laid out in Portuguese East Africa and much smaller plantations in Uganda and Nyasaland. Elsewhere there has been some plantation development in Angola and French West Africa. in Haiti and in Salvador.

* Sisal is the product of *Agave sisalana*. Henequen is produced from other species of Agave, probably a mixture of two or more species, but, since both fibres serve the same industrial purposes, henequen is always included in the classification.

Between the years 1920 and 1939 production of sisal rapidly expanded both in East Africa and in Indonesia, rising from about 20,000 tons in both areas to 144,000 tons in British East Africa and 104,000 tons in Indonesia.

With the occupation of Indonesia and the Philippine Islands by the Japanese in 1942 export production of both manila hemp and sisal ceased and has not as yet been resumed on anything but an insignificant scale.

In consequence the Allies became mainly dependent on East Africa and Mexico for their supplies of hard fibre during the war and this position has persisted until the present. Under pressure of war-time and post-war demand, and despite difficulties due to shortages of labour and machinery, production in East Africa has continued to expand. On the other hand, production of henequen has remained constant for many years at about 100,000 tons annually.

Table I, compiled from figures contained in the reports of the Commonwealth Economic Committee, shows the production and export of hard fibres from the principal producing countries during the past 19 years. The figures show clearly the preponderant position of the East African sisal industry.

Table II shows how the planted area in Tanganyika and Kenya has expanded during and since the war and indicates the

possibility of further expansion. Although there is abundant land available, factors limiting expansion are, on the one hand, the labour supply and, on the other, the demand for the fibre and the future trend of market prices.

History of the East African industry

The natural home of the agaves is in the Yucatan peninsula of Mexico, and the production of fibre has been an established industry in that region for an unknown period. The methods of extracting the fibre are relatively crude, but the industry expanded chiefly owing to the suitability of the fibre for making binder twine for reapers and binders used for harvesting cereals and the growing demand for this stimulated production.

In 1836 the United States Consul in Mexico, Dr. Henry Perrine, despatched some suckers of the species of agave (probably *A. sisalana*), known to the Mexicans as Yax-ci, to Florida. They were successfully established and became the nucleus of the sisal industry in other parts of the world. There were many attempts to introduce the crop to other countries, notably to the West Indies, where at the end of the 19th century endeavours were made to establish the industry on some scale in the Bahamas. These, however, did not succeed, mainly because there was no suitable machine for extracting the fibre.

In 1893 Dr. Richard Hindorf, a German scientist, obtained planting material in Florida and took it to Tanganyika, then a German colony. From these plants plantations were developed and the industry was created. A factor which played an important part was the invention of the Corona decorticating machine, which extracted the fibre satisfactorily on a large scale and superseded the raspadors, which were up till then the only decorticators available.

The first commercial shipment of fibre was made from Tanganyika in 1900 ; it amounted to 7½ tons and was derived from a plantation containing some 4,000 sisal plants. Subsequently the industry expanded rapidly, new plantations were established and by 1913 a total of 61,000 acres had been planted under the crop, the exports for the same year amounting to 20,835 tons.

Developments in Kenya started somewhat later, no doubt influenced by events in the adjoining territory of Tanganyika. Planting material of *A. sisalana* was obtained early in the present century, presumably from Tanganyika, and introduced into the colony, and by the end of 1903 some 1,000 acres had been planted in the Fort Hall district. Development was somewhat slow, but in 1913 7,000 acres had been planted and exports amounted to 1,073 tons.

TABLE I

PRODUCTION (*P*) AND EXPORT (*E*) OF HARD FIBRES IN THOUSANDS OF TONS, AT THREE-YEARLY INTERVALS

Countries	*Kind*	1930 *P*	1930 *E*	1933 *P*	1933 *E*	1936 *P*	1936 *E*	1939 *P*	1939 *E*	1942 *P*	1942 *E*	1945 *P*	1945 *E*	1948 *P*	1948 *E*
Tanganyika ..	Sisal	47	50	77	70	83	81	106	93	126	136	112	111	?	?
Kenya and Uganda ..	,,	17	16	17	20	35	36	38	31	29	34	32	30	?	?
Total : British East Africa ..	,,	64	66	94	90	118	117	144	124	155	170	144	141	156	146
Portuguese East Africa ..	,,	10		15		19		15		12		16			
Dutch East Indies	Sisal with little manila and cantala	65		93		75		104		—		—			
Haiti	Sisal	—		4		6		7		11		9			
Angola	,,	—		2		—		6		4		12			
French West Africa ..	,,	1		3		4		3		1		2			
Mexico ..	Henequen	90	59	100	98	110	101	84	75	111	66	100	50		
Salvador ..	,,	1		2		—		—		—		6			
Philippines ..	Manila	192	167	132	150	192	167	176	175	—		4			
	Maguey	11		6		27		3		—		—			
Mauritius ..	Furcraea	2		1		1		—		1		1			
New Zealand ..	Phormium	14	9	5	4	8	6	5	2	3	—	5	—		
St. Helena ..	,,	1		1		1		1		1		2			

NOTES. (1) 1948 figures are obtained from the East African Sisal Growers' Committee.
(2) Single figures followed by blanks indicate that the production and export figures are identical.
(3) Blanks in production columns show that less than a thousand tons were produced.

TABLE II

EAST AFRICA

RETURN OF PLANTED AREAS AND DEVELOPMENT, 1946

	Tanganyika	*Kenya and Uganda*
	Hectares	*Hectares*
Already planted up to 1940	100,830	
Planted in 1940	7,841	
,, ,, 1941	9,285	
,, ,, 1942	6,614	Details not available.
,, ,, 1943	8,896	
,, ,, 1944	8,917	
,, ,, 1945	13,416	
,, ,, 1946	15,016	
Totals	170,815	80,501
Mature areas	129,910	63,344
Immature		
Old areas replanted	26,324	17,157
New development	14,581	
	170,815	80,501

The first World War

The outbreak of the first World War seriously disrupted the Tanganyika industry. The territory became the site of extensive military operations and sisal production was abandoned for the time being and many of the best plantations became overgrown. Plantings poled and resuckered among a thick growth of weeds and by the time regeneration was begun at the end of the war many of them might almost have been described as covered in secondary bush.

The cessation of production in Tanganyika gave a strong impetus to sisal planting in Kenya, shortage of supplies and consequent high prices providing the necessary inducement, and by the end of the war the exports amounted to 16,000 tons annually.

At the end of the war Tanganyika passed under British mandatory control, but the revival of the sisal industry was beset with many difficulties ; the ownership of plantations was one, since the German-owned estates had been sequestrated as enemy property. Many of the younger plantations had passed maturity before machinery for treating the crop could be installed and on this account cutting could not be undertaken until the deficiency had been met.

Gathering leaves in bundles for transport

Subsequent developments

However, rehabilitation was vigorously undertaken as soon as these matters were settled, and by 1925 most of the difficulties had been surmounted and the industry had once more been placed upon a sound footing. In that year the area under the crop amounted to 114,000 acres, while 25,022 tons of fibre were exported.

Fortunately, the period coincided with high prices and in 1925 the ruling market values were in the region of £52 per ton.

Subsequently the influence of increasing production in the Dutch East Indies, coupled with the expansion of the East African industry and growing outputs in other places, such as Portuguese East Africa, caused a marked decline in prices. This became intensified with the onset of the world trade depression in the early 1930s, and by 1931 the price had slumped to as low as £15 per ton, at about which level it was maintained for a number of years, while production continued to increase owing to extended plantings. By 1936, for example, production in Tanganyika amounted to 83,000 tons, while in Kenya and Uganda it amounted to 35,000 tons, making a total for East Africa of 118,000 tons.

Under the stress of low prices the organisation of the industry was improved, and on this account the effects of the slump were to an extent salutary. Planting interests combined to form associations for their mutual protection and safety ; standard grades were established for the produce, and this created confidence among importers. Great improvements were made in the organisation and management of properties, and of the labour forces employed upon them, which led to considerable economies in the cost of production.

Research

A further important development was the commencement of organised research. In 1934 a Sisal Research Station was established at Mlingano, in Tanganyika, as part of the Department of Agriculture, and with the aid of grants from the Colonial Development Fund and assistance from the industry itself.

Somewhat later a similar but smaller station was established in connection with the Kenya sisal industry at Thika, while about the same time research work on utilisation of sisal was also inaugurated in the United Kingdom.

Of late years the industries in the two territories have become closely integrated and research both in Tanganyika and Kenya is closely co-ordinated.

Some results of field investigations

Field investigations at Mlingano have thrown much light on cultural practices and among the points which have been elucidated are such matters as planting distances, tillage operations, optimum cutting periods and new varieties. Some of the main results are summarised below.

Planting distances. Wide spacing of sisal plants has been found to produce heavier and longer leaves, but there is a high percentage of waste when the fibre is extracted. The same thing occurs when sisal is heavily manured. Close spacing produces shorter leaves, but with a higher percentage of fibre and less waste, the result being due to increased competition between plants.

Fibre yields at various distances of planting show the following results as an average of 10 years' experiments :

TABLE III

Density of Plants per Hectare	*Spacing in Metres*	*Total Yield of Fibre in Tons per Hectare*
10,000	2 x 0.50	31.30
6,666	3 x 0.50	23.22
4,166	2.40 x 1	19.09
1,666	3 x 2	11.69

A ridging machine for sisal cultivation made by James A. Cuthbertson Ltd.

TABLE IV

RESULTS OF CUTTING TRIALS

When Cut	*Tons Fibre per Hectare*	*Average Leaves Grown per Plant*	*Average Number Cut per Plant*
Years			
2	12.80	218.1	186.8
3	11.40	211.8	140.3
4	7.99	207.2	91.0
Months' Cycle			
6	11.42	214.6	147.1
12	10.44	211.1	138.5
18	10.33	211.3	132.5

Time of cutting. Early cutting induces the plant to produce more leaves ; individual leaf weight tends to diminish, but, provided too many leaves are not cut at one time, this does not significantly affect the yield of fibre per acre. The dominant factor is the total number of leaves harvested, and the aim should be to plant at optimum density and to begin cutting early. If cutting is delayed too long a big crop may be produced at the first cut, but heavy poling may follow, with only light yields subsequently. If light cutting is commenced at two years and continued every six months, the life of the plant may be extended to six years or even more with increased yields. Early cutting produces somewhat smaller leaves, but they are more constant in size, while the grade of the fibre is also more constant.

Table IV shows the results of cutting trials over a term of years.

Cultivation. A weed cover reduces the yield of fibre but prolongs the life of the plant ; weed growth competes with the sisal plants for plant food, and in consequence unweeded plantations are slower to attain maturity, *i.e.* the poling stage. Loss of early leaves from withering increases with intensity in weed growth. Cultivation induces larger yields of leaves and hastens development, but the effect is greatest during early growth and is less significant after the third year. Clean weeding is therefore advisable during the early stages. Cover crops have no adverse effects if they are sown after the plants have reached the bearing stage and can with advantage be introduced at that stage to preserve the soil from subbaking and erosion. Table V summarises results of experiments on cultivation.

New varieties of sisal

That sisal produces viable seed was discovered by Longenot in 1929 and a considerable number of seedlings has been raised at the East African Agricultural Research Institute and subsequently propagated vegetatively. Altogether some 40,000 seedling hybrids have been raised and planted at Mlingano. They show great variation, but it may well be that selection from seedlings will in due course lead to the isolation and propagation of new types and varieties which will be better adapted to differing soils and environments and may result in improved yields.

TABLE V

RESULTS OF CULTIVATION EXPERIMENTS

	Tons Fibre per Hectare	*Percentage Leaves Cut per Plant*	*Average Number Leaves Lost per Plant*	*Number of Months to Poling*
Clean weeding and deep cultivation ..	19.89	86	31	53
Surface clean weeding	19.58	84	36	53
Weeding twice a year	13.49	73	58	65
Cover crop	13 38	72	61	59
Weeds cutlassed twice yearly	11.69	66	77	89
Uncontrolled weed and bush growth ..	11.14	65	81	107

Mechanical cultivation and processing

Shortage of labour has of late years caused the industry to turn increasingly to mechanical methods of cultivation and for clearing and preparing land. The use of bulldozers and heavy tractors for clearing land for sisal cultivation is increasing rapidly, and concurrently more and more use is being made of heavy tractor-drawn implements for preparing land for planting. Some English firms of machinery manufacturers have developed types of plough especially designed for preparing land for sisal.

The extraction of fibre has also been the subject of much attention. The original Corona machine was of German design and manufacture. It consists essentially of two rapidly revolving drums with projecting beaters, to which the sisal leaves are presented, the pulp being stripped away by the drums as they revolve and the fibres being left. This was, in effect, the principle of the American raspadors, but in them the fibre was inserted and withdrawn from the machine by hand, the work being slow and not devoid of danger to the operative. In the Corona machine the leaves are held in position and successively presented to the drums by crossed ropes, thereby greatly speeding operation, decreasing labour requirements and reducing operating risks.

After the first World War decorticators of other makes embodying the same principle as that of the Corona machine came on the market. Many modifications were introduced and new types evolved. Attempts were also made to devise alternative methods of decortication, but so far none of them have been able to compete successfully with the principle embodied in the Corona machine.

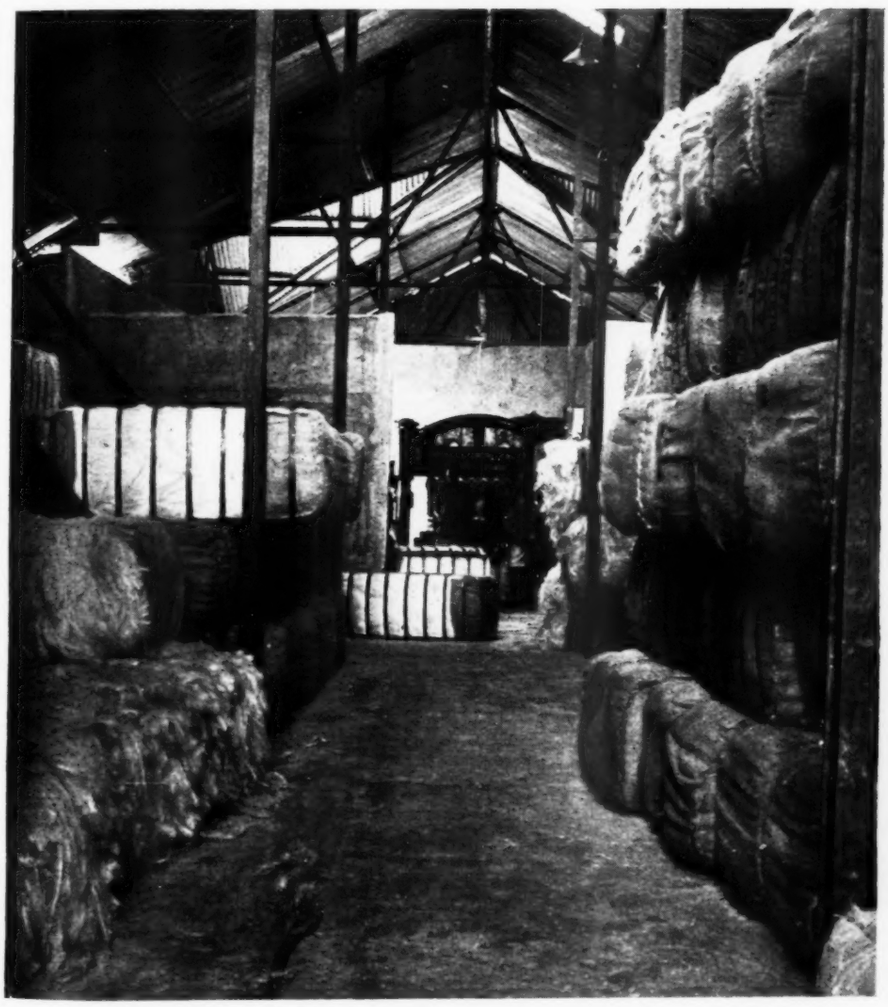
The delivery site of a decorticating machine

Outlook for the industry

The original main outlet for sisal was for binder twine for use with reapers and binders, and it is still the most important purpose for which it is employed. However, the invention of the combine harvester-

The sisal train in a field of one of the large plantations

Sisal fibre pressed into bales ready for shipment



thresher, which does away with the binding of the sheaves, threatened greatly to decrease the demand for binder twine and caused alarm in the industry. The situation today is more hopeful, however, since the introduction of another machine, the hay baler, is expected to increase the demand for binder twine once more. In any event, however, the main dependence of the sisal industry on binder twine makes it liable to suffer from annual fluctuations in cereal crops, while the same thing holds true in regard to its use with hay balers.

In these circumstances the industry has for long sought alternative outlets for its produce and, of these other forms, cordage is the most obvious and the most promising. The chief competitor of sisal in this respect is manila hemp, which is generally regarded as the best fibre for making large ropes and also many sorts of twine. In particular, the resistance of manila to sea water makes it specially valuable for marine cordage. For many years trials have been in progress to test the suitability of sisal as a substitute for manila, and in the British Navy sisal ropes are used for many purposes. However, there is still a decided preference for manila among manufacturers of marine cordage. Research is going on with the object of reducing absorptive power of the fibre by impregnating it with various substances, and seems to hold out promise of successful results, while the present very restricted production of manila affords an opportunity for sisal further to consolidate the position it has won as a cordage fibre.

Another direction in which the fibre finds employment is for weaving coarse sacking material in place of jute. The fibre is much harder and coarser than jute and requires to be treated before it can be woven. Sisal sacks are generally regarded as inferior to jute sacks. Nevertheless, they have achieved popularity in a number of places. For example, in Cuba sugar bags, and in Salvador coffee bags, have been made for some time from sisal.

The first attempt to establish a factory for manufacturing sisal goods took place in 1932 at Kange, near Tanga, in Tanganyika. It embarked upon the production of sacks in the first instance, but subsequently extended its operations to include twine and cordage. The enterprise did not succeed, however, and was closed down in 1935.

A second attempt was made in 1938, when a factory was opened by local planting interests at Ruiru, near Nairobi. This factory supplied sandbags, camouflage nets and ropes for the military authorities during the war. It also furnished, and continues to do so, sacks and cordage for local mining and agricultural industries, as well as

producing a number of fancy articles, such as mats, carpets, handbags, etc., for local sale.

By-products of sisal

In the extraction of sisal large quantities of waste material are produced; these include flume tow, which comprises the short and waste fibres which are unsuitable for shipment, and enormous quantities of waste vegetable material derived from the scutching of the leaves, the disposal of which has often proved difficult.

The establishment of factories for spinning and weaving sisal for local uses provides an outlet for, at any rate, a part of the tow and waste fibre, while recent research has shown that the sisal flesh can yield certain industrially useful products, the chief of which are a wax, glucose and soluble pectates, as well as certain organic acids. The most important seem to be the wax and the pectates. Commercial exploitation of some of these products has been taken up on a semi-commercial scale in England and developments on a much larger scale are planned in East Africa. Recently, material made from sisal waste has been used successfully for consolidating water-bound earth roads (see WORLD CROPS, October 1949, p. 69). Recently, also, sisal flesh or bagasse has been used as a cattle food in Haiti after dehydration.

Conclusion

During the war and until recently the sisal industry in East Africa was controlled by the British Government, who purchased the whole production, but the control has now been removed and sales are now made on the open market.

While the existing shortage of hard fibres continues and the main sources of production remain concentrated in the East African and Mexican regions, the outlook for the sisal industry remains fairly favourable, but as production expands and with the resumption of production of sisal in Indonesia and the revival of the manila hemp industry supplies will increase and prices may be expected to fall. In these circumstances the efforts of the industry to improve production through research and to cheapen costs by mechanisation, combined with the development of new uses for the main product and the possible utilisation of the waste material, should assist the industry to meet the difficulties arising in a competitive market if and when they materialise.

Green Crop Conservation in Germany

THE combined report of two missions which visited Germany to study methods of green crop conservation has now been published as No. 9 in the Agriculture Overseas Series.*

The first mission, which consisted of Mr. H. J. Dent, Mr. J. W. Harland, Mr. G. Saunders and Dr. R. E. Slade, all of the National Farmers' Union, found that the majority of the drying plants visited had been installed primarily for the purpose of drying sugar-beet tops. They suggested that a second mission should visit Germany to make a further study of the subject during the beet harvesting season. This mission was a joint one, consisting of representatives of the Agricultural Machinery Development Board and the National Farmers' Union. Its members were Mr. F. Rayns, Mr. C. Cameron-Brown, Mr. W. F. Williamson, Mr. Gordon Saunders and Dr. R. E. Slade.

The report deals mainly with the conservation of sugar-beet tops, as these provide the bulk of the material used for drying and ensilage making. It also examines the methods of harvesting and handling the sugar-beet crop.

Harvesting beet in Germany is based on the Pommritz system, and is described as a three-stage operation of topping, lifting and carting, which has been developed during the last ten years through mechanisation of the Pommritz system. The aim is to secure the minimum loss of beet and leaf and to save the tops in the cleanest possible condition. Members of the missions were favourably impressed by this system of harvesting and they recommend that an investigation should be made into the possibility of adapting the technique to British conditions.

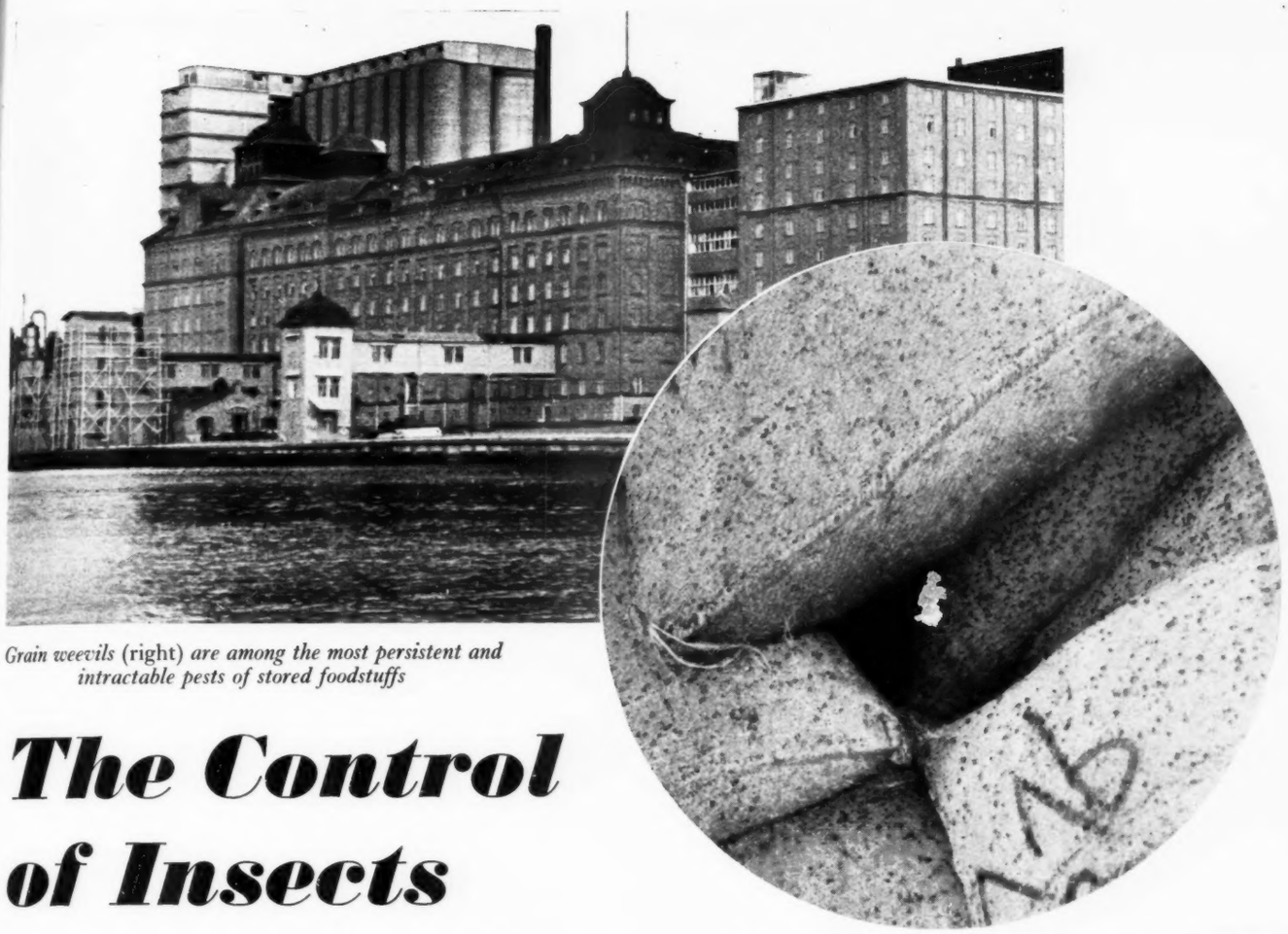
Sugar-beet tops are ensiled by the ' cold ' process, in which the temperature does not rise above 70°F. In this process, the silo or clamp is filled as quickly as possible and then sealed to exclude air. The advantage of the ' cold ' silage process lies in the shorter time taken to fill the silo and in the more efficient organisation of the labour force thereby possible. The process also avoids fluctuations in temperature which might adversely affect the quality of the product. On the other hand, effective covering and drainage are necessary in order to prevent waterlogging. The report suggests that this method of conserving beet tops seems likely to be suitable in Britain and recommends that a trial should be undertaken as soon as practicable.

In Germany, crops which are to be dried are first shredded or chopped. Beet tops may also be treated in order to remove dirt. Washing is most commonly employed, although this involves the use of expensive equipment and increases the labour and cost of the drying. The washed tops are sometimes squeezed mechanically to remove excess moisture, but this results in a loss of dry matter. The alternatives to washing are to harvest clean beet tops from the field or to remove the dirt from the dried material. Neither of these methods appears to have been perfected in Germany. The mission suggest that specially constructed machines and a new field technique for handling beet tops are required; they also recommend an investigation into the mechanical methods of removing sand from dried beet tops.

Of the driers seen, most were of the drum or pneumatic type. A combination of these two types has recently been introduced and might have some advantages for factory use. The report indicates that the fuel efficiency of the combined type is of the same order as British driers, several of which are suitable for the drying of sugar-beet tops.

Particulars of analyses of samples of beet-top silage and of dried beet tops brought back from Germany are quoted in the report. These show that beet tops, either fresh or in the form of silage, are a useful food for the maintenance ration of cattle and may be classed in the same category as kale, cabbage or mangolds. Dried beet tops, on the other hand, may be regarded as a concentrate and are rather similar to oats in feeding value. The report deplores the large-scale ploughing-in of beet tops in Great Britain and points out that the increase in crop yields resulting from this practice can be obtained by other means and does not compensate for the loss of a potentially valuable feeding stuff. In addition to the trials of the ' cold ' silage process in this country, the report recommends that attention should be paid immediately to the practicability of drying part of the crop of sugar-beet tops.

*' *Green Crop Conservation in Germany* ' (*B.I.O.S. Final Report No.* 1858), *published by H.M.S.O. Price* 1*s. net.*



Grain weevils (right) *are among the most persistent and intractable pests of stored foodstuffs*

The Control of Insects Infesting Stored Foodstuffs

E. A. PARKIN, Ph.D.

Pest Infestation Laboratory, Slough, England

F.A.O. places the losses which annually occur in world cereal crops as a result of insect infestation during storage and transport at anything up to 10%. If this enormous wastage could be reduced or eliminated it would enable a great addition to be made to world food supplies. The factors involved and the problems of control and their solution are discussed in the following article.

As the population of the world increases and standards of nutrition are raised, the storage of crops becomes more and more important. This applies especially to crop products which can reasonably easily be kept for long periods without deterioration ; typical examples are pulses, soya, coffee, cocoa, groundnuts, dried fruits and, most important of all, the cereal grains, including wheat, maize, rice, barley, oats, rye and sorghum.

Two things complicate the problems of grain storage : (*a*) the need to ensure that the grain is sufficiently dry before storage, and (*b*) the need to protect it from insect and rodent infestation. Failure to meet these may result ultimately in grain becoming inedible through germination, heating, rotting and contamination with insect remains or by rodents, but before this stage is reached considerable losses may occur through partial spoilage, chiefly by insects and rodents.

Insect damage

The widespread losses caused by insects to growing crops are generally recognised, but the damage they do to crops which have been harvested and put into store is much less widely appreciated. It is, however, very great. The Food and Agricultural Organisation of the United Nations has recently assessed storage losses of cereals at an annual average of between 5% and 10%.

The last 10 years have seen great advances in knowledge of the causes, effects and control of infestations in stored foodstuffs, particularly in the United Kingdom, Australia, Canada and the U.S.A. The subject is attracting attention in many other countries also and the Food and

Agriculture Organisation is fostering efforts to put the prevention and control of infestation on a co-operative, international basis. The more important insect pests of stored products have now become cosmopolitan and it will be a great advance if control measures can be put on an international basis. Existing knowledge enables some effective control measures to be applied under a wide range of conditions, but much more knowledge of the biology and control of the insects concerned is still required, even in countries where infestation control is well organised and executed.

The essential point is, however, that the timely application of preventative and remedial measures against insect infestation is a method of increasing food supplies without increasing the area under cultivation and without an increased demand for fertilisers.

Types of stowages and infestations

Before considering protection measures, some account is needed of the conditions under which the insects occur and insecticides may be applied.

A few species of insects which attack stored products are able to start infestation in the crop before harvesting ; for example, the rice weevil, *Calandra oryzae*, and the angoumois grain moth, *Sitotroga cerealella*, often infest ripe, standing grain, especially maize, but, on the whole, infestation usually starts during storage and it is the conditions of storage which conduce to its spread.

Methods of storage

Among primitive people methods of storing grain generally involve keeping small quantities, either threshed or unthreshed, in pots, baskets or cribs, the grain being covered with straw, mud, dung, etc. As an extra protection the outside of baskets and cribs may be plastered with mud or dung ; or the container may be sunk in the ground if the water-table is sufficiently low. When several tons of grain are involved, storage before threshing may be in loose heaps in the open, or in thatched ricks, or in various types of sheds and barns, while for storage after threshing stores may be built in the manner of native huts, or constructed of bricks, concrete or corrugated iron : alternatively, chambers may be excavated in the ground and lined with mud, dung, metal or cement, the opening being kept small to facilitate tight closure.

Larger quantities, say, from 10 to 100 tons or more, are commonly stored by increasing the numbers of small storages ; this facilitates rotational turn-over, reduces slightly the risk of spread of any infestation and permits treatment of convenient units. In other conditions the grain is frequently stored in bags in sheds, small warehouses, go-downs, etc., which can vary in design and condition from very poor to very good.

Grain sacks webbed by exudations from the Cacao Moth (Ephestia elutella)

When it comes to the storage of large quantities of grain in bulk, methods vary considerably according to the country and the conditions. In countries with a very low rainfall, *e.g.* Upper Egypt and the Sudan, large quantities of grain amounting to many hundreds of tons are frequently stored in piles in the open air. In countries where the climate is more humid similar piles may be stored in open-sided sheds. More frequently storage is in closed go-downs, sheds or warehouses, the grain being stored either loose in piles or in bags. The most modern form of storage is in silos specially constructed for storing and handling loose grain. The best of these are equipped with grain driers and with provision for ventilating the stored grain and a gas-circulating system by means of which it can be fumigated.

Much information is available about conditions of storage and infestation in modern silos and in bulk-storage warehouses, but far less concerning the smaller and more primitive storages. Nevertheless, the total amount of grain stored in small stores for local consumption far exceeds that kept in the major storages handling grain for international trade. There is, indeed, great need for an organised survey on a world basis of the different types of local storages, and of the conditions of temperature, humidity, carbon dioxide content of the air, etc., to which grain is exposed in them, as well as of the type and extent of deterioration which occurs.

Until this gap is filled, recommendations for preventing or reducing infestation by the use of insecticides must often be made on an inadequate basis.

Transport conditions

Products destined for export must be transported in carts, lorries, railway wagons, barges and ships. If the produce is infested after unloading insects may remain on the vehicle or ship to invade the next, perhaps uninfested, consignment to be carried. It is therefore important that any transport known or suspected to have carried infested goods should be treated and disinfested. One must not forget, in this connection, moreover, how easily insects can be spread by the re-use of sacks which have not been adequately cleaned.

Cross-infestation

In larger sheds, go-downs and warehouses, and especially in the holds of ships, many different types of goods may be stored in close proximity, with risk of cross-infestation by insects crawling or flying from one pile to another. The risk

Primitive method of protection—baskets covered with mud

is by no means confined to co-storage of similar types of produce, for, although many stored product insects are restricted in their choice of foodstuffs, others are not. For example, caterpillars and moths of the Cacao moth, *Ephestia elutella*, may spread from cocoa beans and seriously damage dried fruits, oil seeds, tobacco, grain, etc. ; or an infestation of grain by the Brown Spider beetle, *Ptinus tectus*, may spread to flour, cocoa beans, dried fruits, spices, dried yeast, etc. Whenever, therefore, a risk of cross-infestation can be foreseen, the emphasis should be on immediate action to prevent it rather than on control measures after the insects have had time to spread.

Bulk storage

When grains and other products have been bulked in large quantities for distribution and export, they generally undergo periods of storage and transport, as the bulks are broken into smaller parcels on their way to the consumer. Thus, a large bulk of imported grain may be divided among several millers, while each miller delivers flour and offals to numerous customers. The opportunities for the spread of insect infestation during this building up and breaking down of parcels are therefore extensive.

The general problems of control

Control measures in principle involve five stages, *viz.* :—

(1) Recognition.
(2) Appreciation.
(3) Prescription.
(4) Application.
(5) Observation.

Recognition includes the discovery of the infestation and its causes and the identification of the insects involved.

Appreciation involves the integration of the factors which will determine the method of treatment and the stage in the life of the infesting insect at which it can be best applied. These factors include the life history of the insects, their feed preferences, their habits and their resistance to insecticides. Moreover, the product must also be considered, its liability to taint, the form in which it is packed, as well as the location and construction of the storage premises. Climatic conditions also affect the matter. As complete a picture as possible must, in fact, be built up of each particular infestation and the attendant circumstances.

Prescription involves the decision whether control can be accomplished by attention to hygiene, *i.e.* cleaning and segregation of infested stocks and improvements in stowage, or whether insecticides shall be used. Satisfactory hygienic conditions can often be achieved only after structural modifications have minimised accumulation of dirt and debris and facilitated operations for cleaning and insecticidal treatment. All new buildings should be planned with this in view. If an insecticide is to be used, a suitable compound must be chosen and decisions taken on its formulation, rate of application, the best time at which to make the application, and the need for repetition of the treatment.

Insecticides must satisfy stringent requirements. A suitable compound must be adequately insecticidal and safe to apply ; it must leave no dangerous residues in foodstuffs and it must not cause off-flavours or discoloration of the produce, or reduce its nutritive value ; and it must be of reasonable cost.

Application covers the choice of apparatus and methods of treatment, together with safeguards to ensure that the treatment is thorough and uniform and without risk to the operators. A properly prescribed treatment can be rendered almost valueless by poor application, whereas careful application can do much to offset poor prescription or the inherent shortcomings of available insecticides.

Observation requires one or more inspections after treatment to ascertain whether the measures have achieved the requisite control and, if they have failed to do so, to deduce the reasons.

Clearly prescribing control measures requires considerable knowledge of insect biology, of the composition and action of insecticides, of the methods of formulation and application, and of the commercial handling of stored foodstuffs.

Insecticides in common use

Insecticides may be divided into three types : (i) respiratory poisons, (ii) contact poisons and (iii) stomach poisons. The respiratory poisons find their way into the insect through the respiratory system ; they comprise the gaseous insecticides or fumigants. Contact poisons exert their action after passing through the integument of the insect ; they include the pyrethrins, D.D.T. and B.H.C. (benzene hexachloride). The stomach poisons, which act after ingestion by the insect, are generally too toxic to man to be used in controlling the pests of stored foodstuffs, but an insecticide, such as B.H.C., may have its contact effect enhanced by its action as a respiratory and/or stomach poison.

Fumigants

Fumigants, *e.g.* hydrogen cyanide, ethylene oxide, methyl bromide, ethylene dichloride, carbon disulphide, are in common use for the disinfestation of stored foodstuffs. They are very toxic to insects and have the very great advantage of ability to penetrate into bulks of commodities, thus reaching insects inaccessible to sprays,

etc. On the other hand, many are highly toxic to man and animals, some are inflammable or explosive, and some may occasionally cause undesirable effects in the foodstuffs exposed to them. Hence their application must always be much under expert control. When the fumigation is finished and the residual gas aired off, however, nothing remains in the product to protect it against immediate reinfestation.

Contact insecticides

When conditions are not suitable for fumigation, *e.g.* when a building, room or chamber cannot be properly sealed, the combined use of hygienic measures and of contact insecticides in the form of sprays, smokes, dusts, etc., must be considered. Again, prescription is a job for the expert, but, because of their lower toxicity to man, the contact insecticides now in general use do not need an expert to supervise their application. Compared with fumigants, contact insecticides, however applied, cannot reach insects inside packages or deep in bulk commodities and rarely exert more than a superficial effect. Their toxicity to insects is variable, depending mainly upon the species of insect and upon the mode of application ; some are relatively persistent and provide a high degree of protection over periods of a year or more. Considerable care must, however, be exercised in applying persistent insecticides to ensure that they do not seriously contaminate foodstuffs, for they are also somewhat toxic to man and animals.

Contact insecticides may be applied as oil sprays, emulsions, dispersible powders, dusts, smokes, etc., the most important bases of these types of formulation for warehouse use being, at present, the pyrethrins, D.D.T. and B.H.C.

The pyrethrins are a complex of insecticidal substances obtained from the flowers of the pyrethrum plant, *Chrysanthemum cinerariifolium*, which may be ground to make a pyrethrum powder or may be extracted. The extract may be formulated in various ways, especially as solutions in mineral oils, the pyrethrins being insoluble in water. Powders and solutions have a slight sweetish odour, but, when inhaled as dusts or sprays, irritate the nasal mucous membranes.

The pyrethrins act extremely rapidly on most insects, causing loss of co-ordination, followed by convulsions (" knock-down "). They, however, lack a reliable lethal effect on some insect species. Moths and their caterpillars are very susceptible and are readily killed, but many of the beetles are relatively resistant. The toxicity of the pyrethrins can be increased by the admixture of activators, *e.g.* sesame oil or piperonyl butoxide, which have themselves little or no toxicity, but greatly increase the toxicity of the pyrethrins. A search for good activators is being prosecuted, particularly in the U.S.A., for by their use two disadvantages of pyrethrins could be significantly offset, namely, their high cost and their lack of reliable action. Other disadvantages of pyrethrum extracts are their tendency, in high concentrations, to stain some commodities a greenish yellow, *e.g.* dried-fruit boxes and bags of flour. When pyrethrins are exposed to light and air they rapidly lose toxicity, but this can be delayed, but not prevented, by the incorporation of anti-oxidants in the sprays. Their rapid initial effect on insects and, especially, their negligibly low toxicity to man and animals have, however, assured the pyrethrins of an important place in the control of insect infestation of stored foodstuffs. They may be applied directly to grain in store without risk to the consumer and without affecting the milling and baking properties.

D.D.T. (1, 1-bis (*p*-chlorphenyl) -2, 2, 2-trichlorethane) is a synthetic compound which can be prepared pure, but is commonly used as a ' technical grade ' product, containing not less than about 65%, and usually about 80%, of the pure material. It has a characteristic, but not pronounced or unpleasant, odour. Investigations are still proceeding to find ways in which it may safely be used for the control of infestation, for D.D.T. is toxic to man and animals and its presence in foodstuffs to the extent of more than seven parts per million is not at present tolerated in the United Kingdom or the U.S.A. ; in many other countries, however, there is no restriction. The accurate determination of such small quantities of D.D.T. in samples of foodstuffs is difficult and no method capable of use in the warehouse, etc., yet exists. More data are badly needed to indicate the amount of D.D.T. likely to be picked up by foodstuffs exposed to it. Even though full data were available, however, there is at present no way of safeguarding against the accumulation of D.D.T. from multiple treatments, given at different stages in the history of a commodity ; each may be innocuous of itself, but in the end that aggregate may be dangerous to the consumer.

Initially, D.D.T. acts more slowly than pyrethrins, but it is ultimately more lethal to most species of insect, though specific differences are large. Stored product moths and caterpillars are more resistant to D.D.T. than to pyrethrins, and a few insects, especially larvae of the Khapra beetle, *Trogoderma granarium*, are scarcely affected by it.

D.D.T. is relatively cheap and readily available ; it is easily formulated into dusts by grinding with inert carriers such as talc, kaolin and pyrophyllite, it can be made into pastes and into water-dispersible powders containing up to 50% D.D.T., and it can be included in smoke generators. Its use in oil solutions, however, is restricted by its low solubility in the higher boiling fractions of mineral oils which are used, at any rate in Great Britain, to avoid fire hazards in warehouses. Oil-in-water emulsions incorporating D.D.T. have also found little application in food storages, because oils like xylene and toluene, in which D.D.T. is very soluble and which can be stably emulsified, are inflammable ; moreover, operators continuously spraying such emulsions in confined spaces need special protection against the fumes of the solvent.

B.H.C. (benzene hexachloride or 1, 2, 3, 4, 5, 6,-hexachlorocyclohexane) is in many respects similar to D.D.T. : it is a synthetic compound and can be similarly formulated. Its only important insecticidal constituent is the gamma-isomer, which forms about 12% of the crude product and can be purified only with difficulty. Crude B.H.C. has a strong, unpleasant, clinging odour, but the gamma-isomer smells only slightly. The gamma-isomer is reported to have a higher acute but lower chronic toxicity than D.D.T. to man and animals and must not occur in foodstuffs in excess of 0.5 part per million in Great Britain or the U.S.A., but because of its greater toxicity to insects it can usually be applied in smaller quantities than D.D.T. B.H.C. usually acts more rapidly than D.D.T., it has a somewhat higher vapour pressure than D.D.T. and is therefore not so persistent, but the vapour has been found highly toxic to insects. This fumigant action has not been investigated under practical conditions, but might well augment the contact action of the substance, especially in the tropics and in confined situations where there is little air movement, as, for example, in the centre bags of large solid stacks.

Like D.D.T., B.H.C. cannot be conveniently estimated in the field, but the smell and off-flavour acquired by many foods after contamination with it are probably sufficient to safeguard against accidental ingestion of contaminated material. This off-flavour, however, can be serious economically if food which does not contain a dangerous amount of B.H.C. is unpalatable. Finely divided or fatty foodstuffs are much more likely to acquire taint from B.H.C. treatments than non-fatty material of relatively large particle size, like grain.

(*To be concluded*)

Machinery for Land Clearance and Initial Cultivation

[*Photo: National Institute of Agricultural Engineering*

P. H. SOUTHWELL

Mechanical methods of clearing land and preparing it for cultivation have attracted much attention of late years. The impetus was given by developments during the war, but since then the bulldozer, the stump-extractor and similar mechanical devices have been applied on an ever-increasing scale to land clearance in agriculture. Recent rises in labour costs and shortages of manpower, combined with the need for rapidly expanding production of food and raw materials in undeveloped regions, particularly in the tropics, have further increased the urgency of the need for finding more rapid and less expensive methods of performing these operations, which have always been among the most arduous of those with which the cultivator is faced. In the following article the most important devices at present available for the mechanical clearance of land are reviewed and described.

THE clearing of forests, brush, swamp and scrub-covered land has obviously been going on for many centuries. During comparatively recent years millions of acres were cleared by horse and hand labour with the aid of explosives. For instance, between 1901 and 1911 the area of grassland in New Zealand was increased by almost 2,000,000 acres, most of it cleared bush. Work of this nature was naturally very arduous and costly and during the last three decades a certain amount of mechanical equipment has been developed to do the job, and this can alleviate some of the difficulties involved. The efficiency with which it can be carried out is greatest when operations are on a large scale : machinery and methods are still by no means perfect and their adaptation for use on small areas naturally results in a further reduction in efficiency. However, recent progress has resulted in the introduction of some very valuable machinery, the use and co-ordination of which in different conditions and terrains remains a matter for local decision.

The easiest land to clear is, of course, that which only requires the removal of surface debris. On areas bearing unwanted vegetative growth the first aim is therefore to convert this into surface debris which can be burnt. The second step is the removal of roots from the soil and initial cultivations can then follow.

The clearing of virgin land or land which has been allowed to revert to natural growth can be carried out by two systems. A prospective farm can be settled and the acreage of cleared land gradually increased year by year or, alternatively, an area can be wholly or partially cleared before division into farms for settlement. The first system was mainly responsible for the cultivation of large areas in the New World and the yearly increase in cleared land is still going on. This is now assisted by small machinery, such as mobile self-powered circular and chain saws, bulldozer blades for light tractors, and tractor-mounted implements. The development of the contract system of machinery operation has, however, made possible the use of heavy specialised land-clearing machinery.

Effect of conditions

It is obviously sensible to clear the smallest and weakest growth first. In some cases the three operations of vegetation and root removal and first cultivation can be

combined. A heavy stump-jump disc plough has been found useful for sagebrush eradication and reseeding operations on prairie lands ; the sagebrush is uprooted and left to die on the surface or windrowed and burnt. Bracken has been successfully dealt with, when the foliage is short, by conventional deep digger mouldboard ploughs, and land bearing a thick mat—for instance, heather—is normally broken with a prairie-buster type plough.

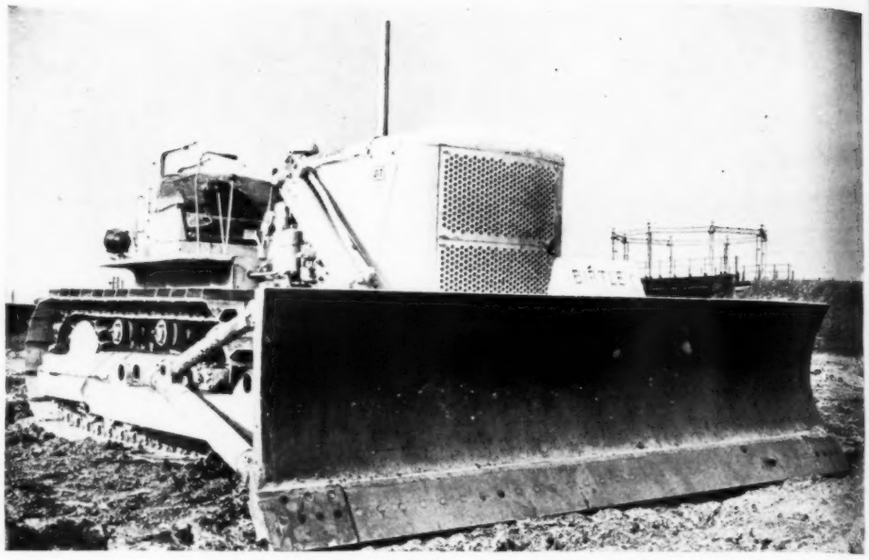
Bush clearing

It is seldom, however, that an area with short slender growth does not also contain larger bushes with which a plough cannot deal. A bush-puller or pusher is a useful implement for uprooting these. A typical bush-puller consists of a steel V, one arm of which is extended to provide a pulling point in line with the centre of the V. In effect, the tool forms three sides of a diamond : the angle of the V is about 40° and the inside edges are ground sharp and/or serrated. The disadvantage is that two men are required—one to drive the tractor or horse and one to guide the puller. Hence tractor-mounted bush-pushers are more popular for this work : they are of two main types operating by either gripping the base of a bush or sapling between spring-loaded jaws or impaling it on a spiked or serrated edge just below ground level.

The uprooting of individual bushes, etc., can often be carried out in conjunction with the first cultivation by use of a gyrotiller. This is a tracked machine of massive construction and consists essentially of two five-tine cultivators rotating in opposite directions. This rotary action makes it possible to prise out stones and bushes of quite large size and at the same time break up the soil : the risk of major damage may be considerably reduced by fixing the tines to the rotors with soft bolts.

Where dense, high bush growth is predominant and there are no trees, clearing may be effected by two methods. It can either be flattened and burnt as it lies or chopped off or uprooted and windrowed to allow root clearing to proceed.

When vegetation is slender and time is not of supreme importance, flattening and burning is normally used. The bush can be flattened by a heavy roller or by logs towed between two tractors ; the latter method has the advantage that some uprooting also takes place. Flat rollers have also been fitted with sharp transverse ribs to achieve better flattening, plus a degree of chopping up in very flexible vegetation. The growth is then left to die and dry out so that it can be burnt on the spot. It is obvious that this method of clearing is best carried out in the dry season and that the greener the growth the more uprooting or snapping of stems that takes place the better. In this connection a track-laying tractor with a strong bar mounted at the front and hauling a set of heavy discs has proved very useful. The bush is flattened by the bar and the tractor and then uprooted by the following discs.



A Jack Olding tractor equipped with angle dozer

To carry out land clearing in the shortest possible time vegetation must be either completely uprooted or cut off near the ground and windrowed so that root clearing may take place whilst the bush is being dried and burnt. A brush cutter consists essentially of a V-shaped shearing blade mounted on a heavy steel frame and flexibly attached to a tractor which pushes it forward. The removable blades are of high quality steel and have a long slope : on cutters which are 8 ft. wide each blade is from 6 to 7 ft. long. A network of steel over the tractor provides protection from falling saplings, etc., and heavy cutters are capable of dealing with 8-in. diameter trees in one cut. Some cutters are built to mount on bulldozer frames and others are attached to the tractor drawbar by beams under or on either side of the machine.

Bulldozers

A useful implement for clearing and windrowing is the bulldozer blade fitted to a tractor. This equipment has come to be the maid of all work in land-clearing operations because it is capable of bush clearing, tree or stump removal, windrowing and levelling. Bush is broken off or uprooted by the bulldozer blade pushed forward just above ground level ; some operators prefer an angledozer blade for this work. Windrowing can also be satisfactorily accomplished and special chisel-shaped blades have been produced for attachment to bulldozer blades to give a serrated lower edge which prevents large quantities of earth being built into the windrows ; these are known as land-clearing blades.

Big, heavy bush rakes and sweeps have also been developed and are mostly of the pusher type so that the tractor may be backed to clear. A more modern implement known as the piler consists of a vertical steel breastwork with heavy horizontal stub teeth or prongs projecting forward from the base. The breastwork is normally a lattice structure and the stub teeth are spaced 1 to 2 ft. apart in order that earth may fall away. When mounted on a tractor with lifting mechanism this equipment has the advantage that compact windrows can be built.

Attachment to tractor

All implements for bush clearing and windrowing obviously require a certain degree of flexibility in attachment to the tractor in order that they may follow the ground contour. In its simplest form the attachment is a pivot and the implement slides along the ground on shoes. This is often quite suitable for sweeps and brush-cutters, but is not so suitable for pilers, and the hydraulic lift has proved most satisfactory in this case and, of course, for bulldozers. Cable hoist is popular in some areas to permit brush-cutters to be lifted over stones, etc., and is preferred to hydraulic systems because of the risk of burst pipelines.

Tree felling

When land is being cleared for pasture some large trees are left standing for shade

A Vicker's tractor with tree-dozer and stumper attached

requirements, but when the land is to be used for arable all the trees should be removed. This can be accomplished by felling and uprooting the stumps or by pulling or pushing the tree over. If it is desired to offset the cost of land clearing by timber sales, it is usual to fell the tree either at ground level so that the stump may be left to rot away or to leave enough trunk to enable the stump to be removed. Little damage is caused to a tree when it is pulled over and timber sale may still be possible, with the added advantage that the big roots are removed in the same operation. Pulling can be carried out by direct pull from a tractor with the hitch as high up the tree as is reasonable and large trees can be dealt with by a system of pulley blocks, using other trees as anchors. Tractor-operated and mounted winches are particularly useful on steep hillsides unsuitable for tractor work. If tractor size is limited, it is advisable to pull a tree and not to fell it unless the stump is to remain.

Equipment is also available for pushing over trees when sale is not a primary consideration. This can be accomplished by raising a bulldozer blade to its maximum height, but special tree-dozers have been developed. These can exert pressure several feet higher than is possible with a bulldozer ; they consist of a narrow notched-edge blade mounted on a hydraulic or cable-controlled framework ; in the latter case the support for the cable sheaves also provides protection for the tractor and driver. Tree removal can be accelerated by fitting a tree-dozer and stumper on the same tractor.

Stumps can be removed by a bulldozer or angledozer—sometimes fitted with a splitting tooth for breaking up very large stumps—but the concentration of effort on the ends of the blades is not very good for the equipment and the operation is lengthy. Furthermore, bulldozers or angle-dozers tend to leave large holes to be filled in and a consequent soft spot which may be troublesome when the area is under cultivation. Stumpers with both a lift and a push action leave a much smaller hole ; they are normally mounted on bulldozer attachments and hydraulically controlled ; they consist of three or four heavy curved tines or a narrow curved blade with serrated lower edge. The procedure is to push on the top of the stump first to loosen the roots and then to dig in with the stumper.

Root removal

The clearing of roots from the land can obviously form a part of the first cultivation and cultivators, especially when tractor mounted, have proved useful for this purpose. Heavy root rakes and root cutters have, however, been developed for large-scale operations and for dealing with the deep, tough roots to be expected when trees growing on a deep loam have been removed. Root rakes usually consist of teeth curved on the bottom half to give a rolling action to the material and to prevent soil build-up ; they have been mounted at the front and rear of tractors, but a trailer type is often preferred, especially for very heavy work. Root cutters normally follow the lines of a mole-drain plough, the mole of which is replaced by a flat triangular blade or blades ; for cutting strong lateral roots the sharp uprights can be supplemented by large discs. Depth control is usually by cable operated from the tractor winch. Some of the heavier machines are capable of lifting submerged stumps and dealing with the very strong tap roots encountered in some areas. A bulldozer land-clearing blade can be used for root combing if the teeth are fully extended to about 2 ft. or more. Root-pickers have also been designed for lighter work and consist of a tractor rear-mounted and hydraulically-controlled framework with heavy teeth jutting down into the soil, but perhaps the most common equipment for this work is the root harrow. This is, in effect, a very heavy drag-harrow, zigzag or otherwise. Cleared roots are then raked off the land and windrowed for burning, preferably with previously cleared brush.

Removal of stones

The only remaining operation is stone removal. Large stones can be lifted on to the surface with a stumper, bulldozer or normal tractor-mounted cultivator and picked up with a tractor-mounted scoop. Very large stones need to be split with explosive. Small stones may be picked up manually and loaded on a stone-boat, but tractor-mounted scoops with a grill floor can to a certain extent minimise this expensive item.

Levelling and initial cultivation

Before cultivations are commenced it is usual roughly to level the land with a bulldozer levelling blade or a series of heavy irons. This operation can be assisted and the surface broken up by use of heavy harrows with long cutting tines.

There are three main requirements in implements for breaking up newly cleared land : strength, weight and some means of avoiding damage. When possible, it is desirable to plough deeply and completely bury all surface trash. The prairie-buster type of mouldboard plough was designed for this sort of work and is particularly useful when a thick surface mat is encountered. It has an exceptional clearance between beam and share, a long mouldboard and turns a deep, wide furrow slice completely upside down ; furrows 30 in. wide and 18 in. deep without choking are by no means impracticable. For dealing with a thick mat large disc coulters can be utilised and when large roots and stones are plentiful a duckbill cutter may be fitted to protect the share. The point of the share fits into a hole in the heel of the cutter and a tie rod prevents the latter from pulling away when the plough is backed out of a stump. When use of a special plough such as the above is unwarranted, a conventional deep-digger model can often do a good job ; deep-running notched-disc coulters have proved helpful in steadying a plough and burying trash, a process which can be assisted by chains. Where obstructions are prevalent the tractor-mounted im-

plement has obvious advantages, especially if a clutch release mechanism or constant draught control is fitted. Single-furrow models are usually recommended and if no rear wheel is supplied a high, long landside is necessary to steady the plough. Stones can be lifted out with the share point of a hydraulically-controlled tractor-mounted implement. Mouldboard ploughs have also been developed on the stump-jump principle and with floating bodies, the coulter acting as a feeler and raising the body through a linkage to prevent damage by hidden stumps and rocks.

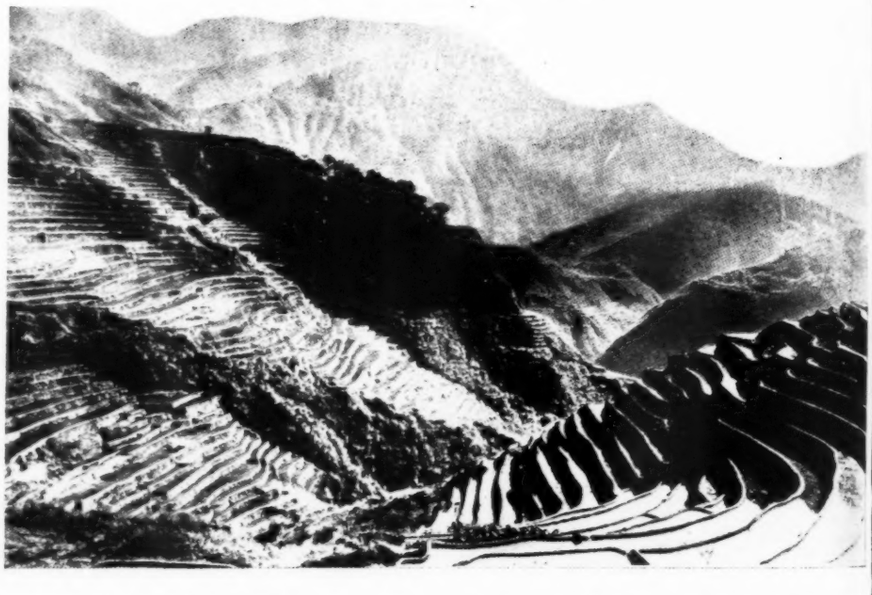
Stump-jump disc ploughs

Stump-jump disc ploughs are extremely useful on land in which trees have been sawn off at ground level or in which obstructions are very prevalent. They are made in two- to eight-furrow models and an Australian firm manufactures a 24-disc model. The discs are dished and usually 26 to 33 in. in diameter ; each is held in work by a coil spring and can ride over any obstructions by compressing the spring without disturbing the rest of the plough. Two rear wheels are often provided to give extra weight and stability and tracks are sometimes fitted for work on swampy land. Ploughing up to 8 or 9 in. can be satisfactorily accomplished and high growth chopped up. These machines are also of use when deep ploughing is not advisable because of poor subsoil—the surface being well broken up—and for the removal of numerous small roots, for instance, following a brush-cutter. Stump-jump disc ploughs are also on the market with alternate large and small diameter discs to help in soil conservation immediately after clearing. It is often possible to turn over the land without ploughing by use of a set of heavy discs, possibly with scalloped peripheries, known as the ' cutaway ' type. There is a significant trend towards use of these heavily-built implements with large diameter discs, particularly where there is an absence of mat on the surface. They are often used after ploughing with a mouldboard plough.

Land-clearing operations have considerable power requirements and are often carried out under very difficult conditions. For these reasons Diesel-engined track-laying tractors are usually chosen as the power unit, although large-wheeled tractors may find a place in some schemes. The advantages of the track-laying machine are its good adhesion in poor conditions, its capacity for utilising high-powered engines in moderate-size machines, its stability and adaptability. For instance, extra wide tracks can be fitted for work on swamp land. The main disadvantages of the track-laying tractor are its high initial cost and high rate of depreciation. It follows, therefore, that the power units for land-clearing work must be kept fully occupied if they are to be operated economically.

Although the bulldozer has become very useful in land clearing, it may well be that this is only a transitional stage and that a framework will ultimately be devised to which bush-pushers, brush-cutters, flattening bars, stumpers, tree-dozers, pilers, root combers, sweeps and bulldozer blades can be easily and quickly attached for use in the appropriate sequence with the same power unit, which can also haul the cultivating implements. There is considerable scope and, in fact, need for the development of new ideas to assist in improving the efficiency with which widely different types of growth and terrain in all parts of the world can be tackled on both large and small scales of operation. The diverse nature of land-clearing work is such that ingenuity and resource must remain important factors in meeting local conditions.

Terraced Rice Cultivation in the Philippines



THE island of Luzon in the Philippines is the site of a remarkable piece of engineering even judged by modern standards, *viz.* the Ifugao rice terraces which range for miles around the mountainside. It has been stated that if the walls, which hold these terraces up and which cover an area of 250 square miles, could be placed end to end they would reach halfway round the world.

There has been much speculation concerning the circumstances in which the terraces were constructed; the consensus of opinion is, however, that this form of culture was brought to Luzon by an immigrant people from Southern China in the second millennium B.C. They were driven up into the hills by subsequent invasions of Malayan people; the existence of the terraces is evidence of how clearly and how well they learned the lesson that soil conservation must be part of successful agriculture under mountainous conditions in tropical regions.

The present-day cultivators are the descendants of the original Ifugao immigrants and they continue to work these lands in accordance with the traditions which have been handed down to them for thousands of years and which have proved their ability to maintain fertility.

The terraces are indeed an outstanding example of the fact that soil conservation has been practised since the earliest times. It is remarkable that despite the lessons of the past the need for conservation measures have frequently been overlooked when tropical lands have been opened up in more recent times elsewhere, and it is not until erosion has taken heavy toll of fertility that the necessary steps to arrest it have been undertaken.

Scientists Discuss Problems of World Food Supplies

Soil erosion, the role of fertilisers, family limitations, the control of pests, the agricultural potentialities of Australia, Canada and the British Colonies, and the achievements of British agriculture during the past ten years were some of the many aspects of the subject of world population and food brought out during a discussion at the recent meeting of the British Association for the Advancement of Science.

This discussion, held under the chairmanship of Sir John Russell, whose survey of this problem was given in our previous issue, is reported below.

IN his opening remarks, Sir John Russell pointed out that the subject was of interest to everyone, for world population was growing at a rate greater than ever before, and every year some land was lost to cultivation. So the problem arose—could all those people be fed? In the old days population was kept down by disease, famine and other causes, but now civilised countries were spending vast sums of money in overcoming those natural effects.

What was the use of saving the lives of children only to allow them ultimately to die of starvation? Was there no hope of reaching that promised land of a higher standard of living for all? So far scientists had been successful in increasing supplies and there was no shortage of foodstuffs in the world today. If we did attain a higher standard of living we should have to have still higher standards of output.

Prof. Pierre Auger, speaking as a representative of U.N.E.S.C.O., said that notwithstanding the benefits which science and technology could confer, students when they arrived at man's estate were often uncertain whether science was a friend or an enemy; too often they regard the machine—the product of science—as something undesirable. However, it was not science or the machine which enslaved man, but man himself. If he wished, man could free himself from disease and from unproductive toil, but it was necessary to make this clear to the ordinary persons who did the workaday jobs.

U.N.E.S.C.O., working with F.A.O., W.H.O. and the U.N. Population Division, was making a major experiment towards mass enlightenment, the aim being to focus the attention of the peoples of the world simultaneously on the urgent problem of population and food, for it was only through international collaboration that the problems could be solved.

Lord Horder, speaking as Chairman of the Advisory Commission on Nutrition of F.A.O., pointed out that food and population were interdependent: one reacted against the other, but the important point was that we should have the will to achieve control—biological control—about which many were still in a stage of confused thinking. It had been stated that primitive populations would have nothing to do with family limitation, but the views of many who have lived among such peoples told a different story.

Although there was much cause for anxiety, Lord Horder looked to the future with confidence, and he offered a five-point creed as a basis: (1) We must take a global view of the problem before us; unless we did so we could not hope to solve it. (2) We must work, because we could never escape the injunction that if we wished to eat we must work. (3) We must encourage ideas, and must secure complete autonomy for science. (4) We could, if we would, achieve physical, chemical and biological control on the earth, and thereby effect a satisfactory adjustment in regard to the present problem. (5) Moral control was the ultimate and over-riding consideration, and the most primitive expression of moral control was 'Live and let live.' Without that even survival could not be assured.

Lord Bledisloe spoke of the achievements of British agriculture during the past ten years. Britain had in his opinion made a very substantial contribution to the world's food requirements. Few countries had increased their agricultural production by 30% since the days before the war, or were contemplating a further increase of 50% in the next few years. Much had

To improve its productivity, stalks and stubble are worked into the surface of the soil; this also prevents the fertile top soil from being carried away by the heavy winds and rain

been achieved by improved methods and the increased and more intelligent use of fertilisers, but there still remained enormous preventable losses due to pests and diseases not only of crops in the field but also among produce which had already been harvested and put into store.

In any event, however, Britain with her large population must continue to be a large importer of foodstuffs, and the national effort for food production would have to be supplemented by imports from other regions and in particular from the Commonwealth.

Frustration in Australia

Sir David Rivett discussed the contribution which Australia could make to increased world food supplies. Many in that continent were far from satisfied with their achievements to date. The rate of development was so slow, the handicaps so many, and the results so disappointing that they were conscious far more of a sense of failure, and even of frustration, than of any glow of success.

If any entertained the notion that in Australia the British Commonwealth possessed a marvellous asset of vast potentialities, that it was a young land capable of superlative development, by direct transfer of the proved practices of countries such as Britain, they should drop it at once. Australia was geologically old, with most of the weaknesses that old age brought to soils, aggravated by shortage of water.

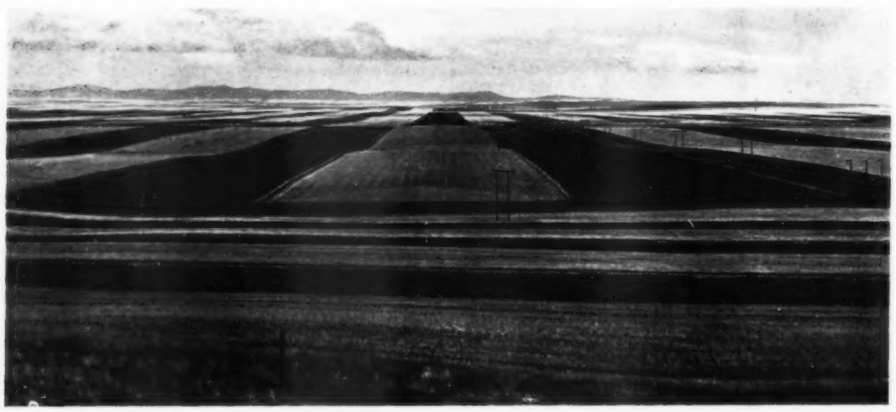
After a brief survey of the available land areas of Australia and their suitability and what was being done to bring them into use by irrigation schemes and in other ways, Sir David Rivett said there had to be high-class scientific knowledge and experimental work all along the line: a fact that was perilously easily overlooked by national planners of these days. The study of natural pasture species under irrigation, the introduction of suitable new species, the growing of fodder crops for fattening stock or as drought reserves, the establishment of legumes to improve the nitrogen status of the soils all clamoured for attention, calling for men, money and time.

The efforts of economists and politicians, well directed and intelligent as they might be, would not suffice to meet the pressing need. It was the scientific men working with all the aid that might be made available to them to whom they had to look for help.

Dr. C. O. Ripley, speaking of Canada, pointed out that although the total area was nearly 1,300 million acres, only 174 million acres represented occupied farm lands, or 13% of the total; while the improved agricultural land was 91 million acres. Possibly the agricultural area might be increased by another 100 million acres, but most of the huge remaining area was unsuitable for food production. Moreover the growing season is only of five months' duration or less and livestock must be stall fed for the remaining seven months. The possibilities for expansion were therefore limited.

Wheat was the principal food grown and production of this and other cereals had increased greatly of recent years. The latest estimate of 1949 wheat production was 391 million dollars; the outturn of wheat had increased twenty-two fold in the last 75 years.

Great attention was being paid to the improvement of crops and agricultural methods, including improved varieties, better methods of cultivation, soil and water conservation, irrigation, weed eradication and the development of hydro-electric power for use on farms. Grassland improvement and livestock breeding are receiving much attention also. All this work should lead to higher yields from the areas cultivated. Progress might be slow; it would be for history to say if it could keep pace with increasing world populations.



Strip cropping is a proven method of increasing crop production in the United States

He thought, however, he was speaking for Canadians when he said they were willing to co-operate to the utmost to produce more food.

In reply to a question, Sir Harold Tempany said that the British Colonial Empire could make a not inconsiderable contribution to increased world food supplies. The Colonial Dependencies were widely scattered and for reasons similar to those already give by Sir David Rivett and Dr. Ripley in the case of Canada and Australia, only a fraction of the total area of some 1,000 million acres could be brought under production; he was inclined to place the maximum at 300 million acres, of which perhaps 100 million were being used.

Much of the land at present cultivated was giving low returns under crude native methods of cultivation on innumerable small-holdings, and the task was to devise means whereby agricultural methods could be improved and something of the efficiency of larger properties could be obtained. This task was being tackled by the Governments of the territories working in association with the Colonial Office and the Colonial Development Corporation.

Implications of population increases

Questioned on the subject of the immediate urgency of checking population increase, Dr. Bronowsky said that although the problem had some urgency he could not disregard the point that hitherto increasing populations had always been able to meet their own food requirements and he thought that this condition of affairs was likely to continue for some time to come, although obviously this could not persist indefinitely.

In reply to another question Mr. G. V. Jacks said that he did not think that increases of population necessarily involved an increase in the incidence of soil erosion. History in fact indicated the reverse, since increased population pressure on the land meant that each unit of area became more valuable the more people a country had to support, and in these conditions efficient soil conservation automatically became one of the conditions necessary for survival.

In conclusion the President said that in the course of a short discussion it was impossible to cover more than a small fraction of the numerous aspects and circumstances involved. He thought it was clear, however, that provided due and timely account was taken of the dangers and full use was made of the resources available, including the rapid advances being made as the result of research in a large number of directions, there was no need for counsels of despair.

World Cereals Today

OATS

G. D. H. BELL, Ph.D., *School of Agriculture, Cambridge*

Oats is a cereal which is particularly tolerant of a wide range of soil conditions. It can be grown in climates too rigorous for wheat or barley, provided moisture conditions are suitable. It is in some places an important article of human diet, but its use is more particularly associated with livestock husbandry. As a crop it plays a predominant part in the farming systems of many countries, notably Northern Europe, the U.S.A. and the U.S.S.R.

OATS exists in only a few recognisable major botanical forms as a cultivated crop, although there are a large number of comparatively minor botanical types which are identifiable. Three major groups of botanical forms are outstanding in contributing to the world crop and, all the cultivated forms are confined to the three major groups; two, however, dominate oat cultivation in the world. The composite, and to some extent overlapping, major groups of forms is usually regarded as associated with the more recent development of oats as a cultivated crop compared with wheat and barley, which are undoubtedly more ancient. There is, however, one biological feature showed by wheat and oats but not found in barley. This is that the evolution of cultivated forms has been accompanied by multiplying the number of chromosomes, so that the most widespread and important types in cultivation have the higher chromosome numbers.

The present wide distribution of cultivated oats appears to have depended on the evolution from two major geographical groups, probably originating in the Mediterranean basin, which gave rise to a western and eastern range of cultivated forms, the former splitting into those with a more southern, and those with a more northern, distribution. These distinctions can be seen today in the particular types which dominate oat cultivation in the important areas of cultivation, and explain, for example, the forms which are peculiar to the moister, cooler climates as opposed to those which are better suited to the drier and hotter conditions. In spite of this distinction, however, there is an extraordinary gross botanical similarity between the cultivated oats of the world, the differences being primarily apparent in physiological characters which suit the particular forms to major climatic conditions.

World distribution and important areas of cultivation

Oats is essentially a Northern Hemisphere crop and is confined for the most part to the cooler temperate regions, preferring maritime climates for the production of the highest yields. The range of successful oat cultivation is, however, extended by the fact that the crop is often not grown to full maturity in the field, but is cut in varying stages of immaturity in order to use the straw in a more palatable condition for stock feed. Therefore, although oats requires a longer growing season for good yields of grain than does

barley and is preponderantly a spring-sown crop because there are no really winter-hardy forms, successful cultivation can be practised in areas where the climate is not particularly suitable to producing high yields of mature grain. It is partly this important consideration which extends oat cultivation into areas where no other temperate grain crop is grown economically, and allows its inclusion as a farm crop in northern regions where other cereals, which require to be grown to full maturity, cannot be grown successfully.

[*This and the photograph below and that on p.113, courtesy of 'Farmer and Stockbreeder*

Oats just coming through on an old pasture meadow

Concentration of the crop in Europe, U.S.S.R. and U.S.A.

The striking feature of the world distribution of the oat crop is its concentration in North-West and Central Europe, the U.S.S.R., and in North America in a zone which takes in much of the northern corn belt in the U.S.A. and the southern parts of the prairie provinces in Canada, though it also spreads to the eastern and maritime provinces in the Dominion. Oats is not an important crop in Asia, and in the Southern Hemisphere only Argentina and Australia can be regarded as large producers. The U.S.S.R. and the U.S.A. are easily the most extensive growers of oats, contributing over half the total world acreage of approximately 140,000,000 acres, but the most intensive centre of production is North-West Europe, where the highest yields in the world are obtained. In the more southerly areas of the U.S.A. and in Southern and South-East Europe, oat cultivation is only possible by the utilisation of special types of 'red oats' which can withstand the higher temperatures and drier conditions.

Economic and agricultural significance

The oat crop has always been cultivated primarily as a livestock feed, and the world expansion of oat growing with its present-day status as one of the important temperate cereals depends on this form of utilisation. Therefore, in spite of the small, but locally important, use of oats for human consumption as oatmeal and other preparations, the crop is overwhelmingly associated with livestock husbandry, the intensive development of which depends very much on the successful cultivation of this crop in many important farming systems in the temperate regions of Europe, the U.S.S.R. and the U.S.A.

The particular virtues of oats as a livestock feed depend on the characteristics of the grain, which provides a feed relatively rich in oil for a temperate cereal crop, while the bulk provided by the husk enveloping the grain adds to its suitability for direct feeding to most classes of livestock. Although oats is grown principally for the grain, the straw is valued for feeding more than that of any other cereal, and in some parts of the world special varieties are grown to provide good yields of nutritious straw.

The special virtues of oats as a livestock feed and the particular role of the crop in the economy of the farm, result in only very small amounts entering into international trade. The characteristic association of oat cultivation with diversified and grassland farming systems where livestock are commonly the major enterprise also militates against the development and organisation of specialised oat-growing for marketing. There are, however, cereal-growing areas where oat cultivation for sale on the open market is an important undertaking, though the grain is usually sold on local markets.

Although there is sufficient winter-hardiness in some varieties for oats to be autumn sown, but with some risk even in the milder climates, the crop is essentially a spring cereal in most farm rotations. In addition to being cultivated as a pure crop for the grain and straw it is sometimes mixed with legumes for the production of a mixed feed, while it is sometimes cut for hay. This diversity in the method of utilisation means that oats occupy many different places in rotations and, taken in conjunction with the wide range of conditions under which the crop is cultivated in most countries, demands a larger number of varieties than is usual with wheat and barley.

Inter-row cultivation with a steerage how. Rows 8 in. apart, nine full blades—two halves

Two types of oats growing in the same field ready for harvest

World production and level of productivity

The average annual world acreage of oats for the period 1935-39 was estimated at 138,840,000, with a production of 4,362,000,000 bushels, giving a yield per acre of between 31 and 32 bushels. Oats is the highest yielding of all the temperate grain crops, because the important centres of production are confined to comparatively limited climatic zones, and agricultural areas characterised on the whole by higher production levels. The ecological association of oats with high rainfall and maritime climates and the agricultural association with livestock enterprises, obviously tend to maintain good yields. On the other hand, the crop is also grown on some of the poorest upland soils and, although these areas are not very extensive on a world basis, the low yields obtained do affect to some extent the general level of productivity.

Oats has the reputation of being less particular in its soil requirements than wheat or barley, in particular being tolerant of greater acidity and alkalinity than the other two crops. It is, however, the climatic conditions which dominate the adaptation of oats, and the more accurate picture of oat cultivation is obtained by recognising that oats can be grown successfully on a very wide range of soils, provided the moisture conditions are suitable. Therefore, although the highest yields are obtained, as with other crops, where soils are fertile and support a high level of productivity, there is the important aspect of world oat production which reflects the tolerance of this cereal to poor conditions. It is significant, for example, that on some of the more fertile soils in good oat-growing areas, the oat acreage has declined because heavier yields of feeding barley can be obtained.

The comparatively high world average yield of just over 30 bushels to the acre which characterises oats, is made possible by the level of productivity of the largest oat producers coupled with the very heavy yields of many of the smaller oat producers. The U.S.S.R., the U.S.A. and Canada, which between them produce over half the world oat crop, have an average yield of over 25 bushels to the acre; Germany and France, which together produce about one-fifth of the world crop, can average between them over 40 bushels to the acre; while the smaller contributors like Denmark, Holland, Great Britain, Eire and Belgium have the highest yields, which vary from 60 bushels (Great Britain) to approximately 70 bushels (Denmark).

Increasing production

The relationship of climate, soil fertility and level of farming with productivity is closer, and for the most part more satisfactorily expressed on a world basis, with oats than with the other temperate cereals. General levels of production are higher, which means a more efficient exploitation of the crop and less leeway to make up for increasing production. The relationship between the growth and yield of the oat crop and meteorological conditions has probably been studied and worked out more thoroughly with oats than with the other cereals, and it is not probable that there will be any great increases in production by taking into cultivation large new areas for oat growing. It is doubtful if the hotter and drier areas of the temperate regions could ever be made to support successful oat cultivation on a large scale, even with the aid of irrigation, and expansion to more inhospitable climates appears to have strict limitations.

There is, however, an opportunity for increasing the oat acreage by avoiding the worst climatic hazards through the breeding of new varieties. The development of more drought- and heat-resisting varieties by utilising the *sterilis* group of cultivated forms has already led to the production of varieties which can be grown economically where the cool climate *sativa* forms are unsuccessful. Similarly, the breeding of higher yielding, stronger-strawed varieties with as great winter-hardiness as the old winter forms has made winter oat cultivation a much better proposition for those areas where spring oats commonly suffer from drought.

Increasing production in the established oat-growing areas depends on raising levels of fertility and the use and introduction of improved varieties. One of the out-

Oats being harvested on the shores of Mounts Bay, Cornwall. St. Michael's Mount is in the background

nding achievements in oat breeding in recent years has been the introduction of high yielding varieties with strong straw which can be grown successfully on the richer soils and in the higher rainfall areas. There is still scope for improvement in this direction, but the fullest exploitation of the new varieties will depend on the development of more intensive livestock husbandry.

Apart from total yield of grain, however, there is the question of quality, which depends on the percentage of husk and the amount of oil in the grain. Thin-husked oats can produce more food to the acre than thick-husked oats and, without increasing the total grain yields per acre, the amount of livestock feed can be raised by lowering the husk percentage. This has been done by breeding and, taken in conjunction with a high oil content, can be instrumental in raising productivity in terms of food values.

In some of the drier and more intensive oat areas, disease is an important limiting factor to yield. Crown rust, which can also be a serious disease in some maritime climates, is an example of a fungal disease which has been attacked successfully by plant breeders, but which needs further attention if production is to be safeguarded and improved. In the U.S.A. the Victoria blight disease has become a serious menace because of the release of new varieties which are susceptible, and it has become necessary to embark on a new breeding programme for the sole purpose of controlling the disease. Although much has been done to increase production by breeding improved varieties, it seems probable that further increases will depend mainly on making available new disease-resistant varieties which are better adapted to local growing conditions and which can give high yields under fertile conditions without lodging.

Disease Problem Overshadows Cocoa Industry Conference

The problem of Swollen Shoot disease which threatens with extinction the cocoa industry of the Gold Coast, and which has now spread to plantations in Trinidad, dominated the conference organised by the Cocoa, Chocolate and Confectionery Alliance which was held recently in London. The discussions of the conference supplement and elaborate on the account of the problems of the cocoa industry which appeared in our September issue.

THE conference was well attended and membership included representatives and scientific staff from the British producing regions in West Africa and the West Indies, representatives of cocoa manufacturing interests in this country, as well as representatives from the United States, France, the Netherlands and Venezuela. It was thus of an international character. Among those present were Professor E. van Slogteren, Dr. W. Carter and Dr. G. A. Berkeley, who formed the Commission of international experts which was sent to the Gold Coast at the end of 1948 to report on the disease position.

The agenda for the conference included papers and discussions on supply and demand, cocoa soils, diseases of cocoa trees, problems of rehabilitation, research into agricultural problems and questions of quality.

Supply and demand

In relation to supply and demand, Mr. Coventry Woodhouse analysed the position and expressed the opinion that for some time to come the probable future production of cocoa would be in the region of 650,000 tons, as against a demand which might be expected to exceed this figure. In the subsequent discussion the general opinion was expressed that the estimate might be too optimistic. It was emphasised that the high production recorded last season in the Gold Coast may have temporarily allayed the fears entertained concerning future production in some quarters. Optimism, however, was not justified, since the threat to the industry from disease had by no means been checked and it seemed likely that yields would fall in the future, while the demand showed every sign of expanding.

Soil requirements of cocoa

Mr. C. F. Charter described the steps that are being taken to map cocoa soils on the Gold Coast and gave an indication of the characteristics of the more important soil types. It was agreed, in subsequent discussions, that, as cocoa is so selective in its soil requirements, it was most important that areas where soils are well suited to the growth of the crop should be accurately delineated and should be used to the best advantage.

Dr. Howard Lees, soil specialist attached to the Trinidad Cocoa Research Scheme, described the results obtained from preliminary investigation of Trinidad cocoa soils and notably the role of trace elements therein ; he apparently considered that copper might play an important part in this connection.

Mr. H. J. Page, principal of the Imperial College of Tropical Agriculture, described progress in the organisation of research at the Imperial College. Good progress had been made in the erection of the buildings and with the engagement of staff. Research was proceeding, notably on the development of high-yielding clones of cocoa, while encouraging results had been obtained in experiments designed to maintain cocoa seed in a viable condition for longer periods than had been possible previously.

In regard to pests and diseases, Mr. Page mentioned the need for some method of demonstrating the presence of cocoa virus during the ' latent period,' during which the tree is infected, although no outward sign of the disease can be seen.

Mr. O. J. Voelcker, director of the West African Research Institute, dealt with the work carried out at that institution. He emphasised that the means of controlling Swollen Shoot disease were now well known, while it was also possible to control capsid bugs by suitable spray applications. The future of the cocoa industry in West Africa depended on whether it could be grown in such a way and under such conditions as would enable the result of re-

search to be utilised. If this could not be achieved the outlook for the industry was indeed dark.

This opinion was strongly endorsed by the conference and it was agreed that neither resources nor staff must be spared in order to achieve this end.

Swollen Shoot disease

A special session of the conference was devoted to the consideration of virus and other diseases of cocoa. Mr. John Cadbury outlined the history of Swollen Shoot disease in the Gold Coast. He indicated the manner in which it had spread and how the difficulties of tackling the problem had been increased by tardy recognition of the dangers and by delay in implementing control measures.

Mr. Kenneth Smith, of the Molteno Institute at Cambridge, described the nature of viruses and the difficulties inherent in their control. Modern science had evolved a number of new techniques which were throwing increasing light on the problem, but until more data were available it was impossible accurately to explain their nature and the transformations which they undergo.

Mr. A. F. Posnette dealt with the question of intermediate host plants for virus disease of cocoa in West Africa. Swollen Shoot is caused by the transmission to the cocoa tree of viruses which have long been pre-existent in indigenous flora of the African tropical forest. The problem is complicated by the fact that these indigenous host plants are tolerant of the disease and frequently show no symptoms. They thus constitute an enormous reservoir from which infections can spread. A certain number of these trees are known, but their eradication is a task of almost insuperable difficulty. It must, in consequence, be regarded as certain that plantations of cocoa will always be liable to infection and the essential point is to reduce this susceptibility so far as may be practicable and once infection appears to deal with it drastically.

Mr. J. D. Broatch, Deputy Director of Agriculture in the Gold Coast, described the current measures to control and to rehabilitate diseased plantations. The task was enormously difficult owing to the scattered and often remote character of the holdings and the unwillingness of cultivators to submit to the only method of control known to be effective, *i.e.* cutting out.

Operations have been handicapped throughout by insufficient staff, inadequate powers, and had been complicated by political issues ; there was no ground for believing that the spread of the disease had as yet been checked. Professor E. van Slogteren and Dr. W. Carter, two of the members of the Disease Commission, endorsed all that had been said by Mr. Voelcker and Mr. Broatch. Dr. Carter was emphatic on the point that unless much more vigorous measures were undertaken the ultimate disappearance of the cocoa industry in West Africa in its present form was only a matter of time. In the discussion which followed there was a good deal of agreement that the ultimate survival of the cocoa industry in the Gold Coast depended in the last resort on the gradual supersession of the present structure of the industry by one in which cocoa was planted in large easily-accessible blocks over which control could be exercised in the necessary degree.

In the West Indies it now appeared that Swollen Shoot had become established in the northern range of Trinidad, while Witches' Broom disease had now made its appearance in Grenada, where it had hitherto been absent. Taking things by and large, there was little in the disease situation which gave cause for optimism.

Attempts to improve quality

The morning of the third day of the conference was given up to the consideration of the question of quality in cocoa and accounts were given, on the one hand, of methods adopted to improve the quality of cocoa from Nigeria. Encouraging results were reported and this was endorsed by representatives of the confectionery trade, both in United Kingdom and the United States. Other papers presented reviewed the question of quality of West Indian cocoa. Dr. Thaysen, head of the Colonial Microbiological Institute in Trinidad, gave an account of the work in progress to determine the changes which took place in cocoa during fermentation.

The proceedings of the conference were summarised by Mr. Paul Cadbury on the last day. He considered that the progress made in research was probably the most encouraging sign at the present time ; the salvation of the industry depended upon research and upon the practical application of the results, and the latter was a problem of particular difficulty.

It was obviously most important that there should be an immediate extension of replanting, since statistics indicated that during the next few years cocoa supplies would probably be insufficient to meet demands.

It was indicated during the course of the conference that the plantation of new areas was in contemplation by the Colonial Development Corporation, but no details are yet available concerning the places where they would be located.

In the meantime, it was obviously essential that the programme for checking disease and for rehabilitating devastated cocoa farms should be carried out on the most vigorous lines and that no pains should be spared to recruit the staff required to accomplish this. In addition, the grading of cocoa should be still further improved and adequate price differentials introduced to encourage the production of better grades.

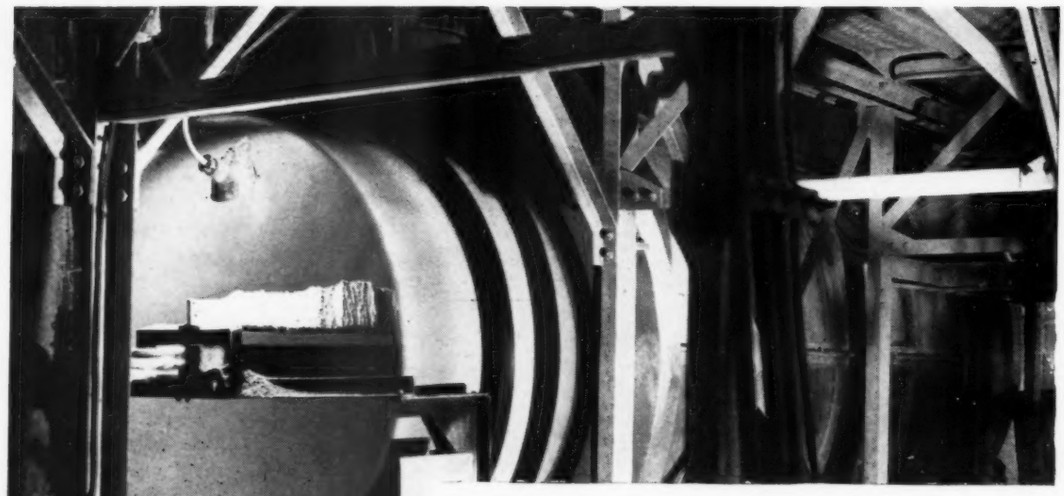
At the conclusion of the meeting it was decided that these conferences should be made a regular annual event. The present difficult situation of the cocoa industry makes frequent and regular provision for consultation and discussion between the different interests involved particularly desirable, and it would seem that the decision is timely and likely to produce valuable results.

A feature of the conference was the discourses given during the luncheon intervals by leading public men on the administrative and political aspects of the difficulties with which the cocoa industry is at present confronted.

Speaking during the first interval Lord Rennell of Rodd vigorously criticised the policy of the present Government in the matter, which he considered was largely responsible for the present precarious position. On subsequent days Lord Rennell's criticisms were answered by Mr. A. Creech Jones, Secretary of State for the Colonies, and by Mr. Rees Williams, Parliamentary Under-Secretary of State for the Colonies. A comment on this subject appears in our Editorial columns.

First Grain Bag Made in Southern Rhodesia

The first grain bag to be manufactured in Southern Rhodesia has come off the production line exactly one year after the first peg went into the ground for the building of the factory in Umtali. This bag is made of imported raw materials, but Urena Lobata fibre grown in the Sabi Valley will begin to reach the factory in two or three months' time. The first crop, Mr. F. J. Vandenbergh, the chairman of the company, said, had already been reaped and was of extremely good quality, the plants growing to an average height of 14 ft. The output of the factory would be gradually expanded. ' It will be a slow flow in the beginning,' said Mr. Vandenbergh, ' because we have to train the natives, but they are learning quickly and we are satisfied that they will be suitable for the trade.'



Granulation of superphosphate is regarded by many as one of the most promising methods yet of reducing the rate of soil fixation of phosphates. The photograph shows the rotary conditioner at Lawes Chemical Co. Ltd., Barking, Essex. In this drum the essential process of granulation takes place. The fertiliser is fed into the top of the drum and sprayed with water. The continuously agitated and sprayed fertiliser gradually passes out to the end of the drum, during which time it has formed into small pellets

The Phosphate Story

D. P. HOPKINS
B.Sc., F.R.I.C.

Of recent years the part played by phosphorus compounds in the nutrition of crops has attracted increasing attention. There has been much investigation in the field and in the laboratory, while the tendency of phosphates to revert to unavailable forms when applied to the soil has been the subject of much research. The problem of making phosphate more available to the plant is discussed in this article.

LIEBIG'S suggestion in 1840 that bone phosphate might be more readily effective as a source of plant food if pretreated with acid was put into successful practice with very little delay. Not only was Lawes's London factory producing superphosphate within a few years but he was easily able to sell all he could produce. The replacement of bone sources of raw phosphate with mineral phosphates was an early innovation. In short, the phosphatic fertiliser invaded 19th century agriculture very smoothly and speedily. It is now a century and a few years old and all through this period world tonnage of superphosphate has been expanding, rising sharply at times of high food demand, and rising or maintaining its current size even during periods of agricultural depression. There has been no sliding back.

Some 30 years after the introduction of superphosphate, new steel processes yielded a by-product slag containing the phosphatic impurities of iron ore. For a few years slag heaps piled up. Then it was thought worth while to test the fertiliser value of this waste material. It was soon found that 'basic slag,' if finely ground, was a slow but effective phosphate supplier. Here again there was rapid practical development from the moment of discovery.

The value of phosphatic fertilisers has been established by hard facts ; if they had not, farming demand for them would never have reached such large and steady tonnages. Our detailed knowledge of phosphate action is however incomplete.

Phosphate deficiency

Many soils used in agriculture are markedly deficient in phosphate; yet they contain enough phosphate to support a series of crops. The explanation for this apparent paradox has long been known. A plant nutrient must first become dissolved in the soil solution and, out of the total phosphate in a soil, only a minute fraction is in the soil solution at any one time. However, as and when the plant removes phosphate, the soil solution's 'state of phosphate saturation' is reduced and it is able to dissolve more from the soil's reserve. What matters most, then, is not the momentary amount in the soil solution but the *rate* at which it is renewed. All experience shows that this rate is much below the rate at which phosphate is needed for good plant growth. The function of a phosphatic fertiliser is to add to the top soil supplies of phosphate which are able to pass fairly readily into the soil solution and thus augment the soil's rate of supply.

Phosphates in the soil

One of the biggest gaps in our knowledge is that we have never been able to isolate and identify the chemical forms in which phosphates exist in soils. They are rarely simple. Complex phosphates are built up, and these tend to change from one to another; a change in the state of acidity of a soil will bring about changes in the phosphate complexes. Broadly speaking, we can put these chemical forms into four groups:

(1) *Fairly readily available.* Calcium and magnesium compounds containing phosphate;
(2) *Fairly available.* Combinations of phosphatic material with organic matter.
(3) *Feebly available or non-available.* Compounds of iron and aluminium containing phosphate.
(4) *Unavailable.* Minerals of the apatite class, *i.e.* the rock-like minerals which must be long weathered before they can be regarded as true soil constituents.

A soil's available or potentially available phosphate consists of the first two groups.

Its much larger locked-up reserves comprise the third group and perhaps the fourth. The phosphatic fertiliser industry's contribution is that it takes minerals of the fourth class from rock phosphate deposits and converts these into phosphates of the first group.

Phosphate fixation

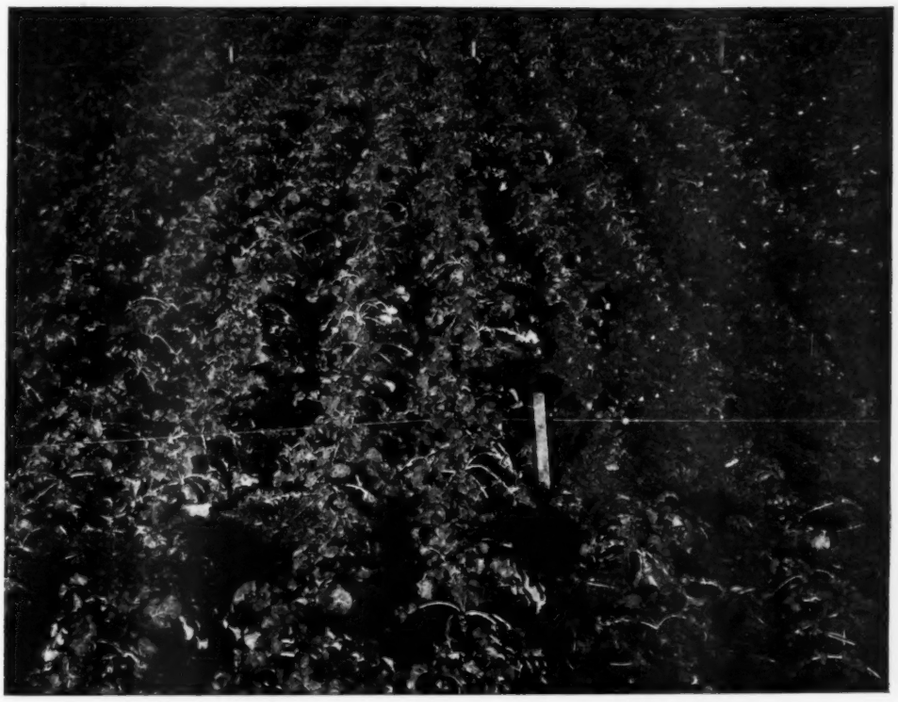
But complications begin to enter the story immediately the phosphate is added to the soil. Some of it may be quickly taken up by the growing plants, but some will react directly with soil chemicals, and the tendency of these reactions is to make the phosphate less available. The standard of efficiency of our major phosphatic fertilisers—in this sense—is very low. Of 100 lb. of soluble phosphate added to a soil, 25 lb. at the most may pass into the crop; the remaining 75 lb. is reverted to less available forms by soil ' fixation.'

Soils vary considerably in their fixing capacity and the rate at which they revert phosphates. An acid soil will have considerable amounts of iron and aluminium in its soil solution and when soluble phosphate is added to it, insoluble iron and aluminium phosphates are formed and a high proportion of the phosphate denied to the crop. On the other hand, fruited or alkaloid soils containing adequate free lime will precipitate calcium phosphates, which are much more available. The effect of organic matter also cannot be ignored, and organic-phosphatic complexes may hold added phosphates in a form that is still potentially available to plants.

Two problems therefore arise, *viz.*: How far can fixation be reduced by attending to the soil condition?; and how far by improving the nature of the phosphatic material added?

Superphosphates

The principal phosphatic fertiliser is superphosphate. Its manufacture is still essentially the same as first developed by Lawes. Insoluble mineral phosphate is ground and treated with sulphuric acid. Most of it is converted into mono-calcium phosphate which is water-soluble; some into di-calcium phosphate which is insoluble in water but soluble in very dilute acids; there may also be some unchanged insoluble phosphate. At first sight this might seem a phosphatic fertiliser of great efficiency. The soluble mono-calcium phosphate should enter the soil solution rapidly and from this plants should be able to assimilate their needs. But it is equally easy, or indeed easier, for soil materials to react with the phosphate in the soil solution. It is said to happen to so complete an extent that when superphosphate is left on the surface of soil, all the soluble phosphate has been ' fixed ' by the time it has penetrated 1½ in. downwards. It is also said that the soluble phosphate in superphosphate has little or no direct feeding value to a plant; the phosphate that a plant derives from it comes indirectly from the products of its first soil reactions.



The effects of phosphoric acid in an experiment on swedes in Northern Ireland. The rows which received no phosphate are on the right

Nevertheless, it cannot be denied that superphosphate is an effective fertiliser, and the broad answer (or at any rate the theory most generally supported) is as follows. Except in the case of acids oils (when superphosphate is not very effective), soluble mono-calcium phosphate is precipitated as insoluble di- and tri-calcium phosphates. These precipitates are, however, of very fine particle size and distributed intimately throughout the zone of soil which the superphosphate penetrates. The soil solution, which is always slightly acid, can redissolve these slowly, and since they are not complex and expose (because of their fineness) a large surface area, they dissolve more readily than the phosphates in the soil's locked-up reserve. This has long been the orthodox reply to those who ask the question: Why go to all this trouble to make a phosphatic mineral water-soluble when it is known that the first thing the soil does to it is to make it insoluble again?

Nevertheless, it must be remembered that the larger part of this precipitated phosphate is *not* redissolved by the soil solution or, if it is, it is again precipitated. For only 20 to 25% at the most is assimilated by the plant. It is this disturbing wastage that has led to widespread theoretical criticism of the superphosphate idea in recent years. Why not add a *non*-water-soluble form of phosphate to the soil and let this be slowly dissolved by the soil solution? Such, after all, is the mode of action of basic slag, or would seem to be; those last words must be added for we are not certain about the detailed reasons for basic slag's effectiveness.

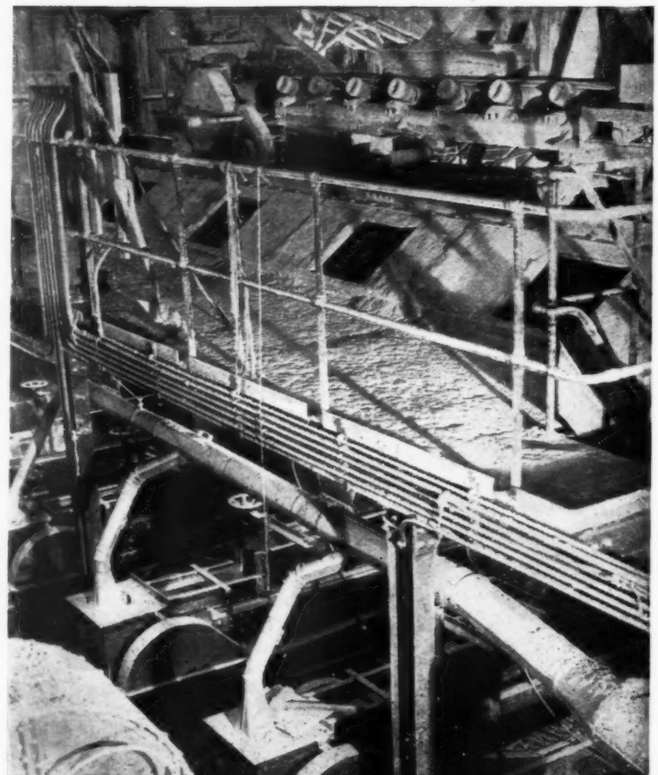
Citric soluble phosphates

There is, however, an empirical test for the value of non-water-soluble phosphates. Dilute solutions of citric acid or ammonium citrate are assumed to have about the same dissolving power as the average soil solution, an assumption which years of application in soil analysis have shown to be reasonably reliable. It has long been a controversy whether water-solubility or citric-solubility should be the criterion for the phosphate value of a fertiliser. In Britain and a minority of countries water-solubility is still the accepted standard, but in the United States, Canada, Sweden, France and other countries the official view is that water-solubility is of little or no extra value and that the citric acid or citrate-solubility is a sufficient indication of the availability of a phosphatic fertiliser. Lately, leading technical opinion in Britain has swung heavily against water-solubility, and many eminent soil scientists have suggested that Britain should abandon the water-soluble criterion in her future

fertiliser legislation. Among these are Sir William Ogg and Dr. E. M. Crowther of Rothamsted.

Placement and granulation

Progress has, however, been made in protecting water-soluble phosphate from soil fixation. Placing the fertiliser application in a row or strip is one protective device, and preparing the fertiliser in a granular form is another. Often the two methods are combined in practice. If a fertiliser is applied in a concentrated strip, its total surface of contact with the soil is much less than if the same amount is broadcast or harrowed in over a wider area. With less contact with the soil the rate of fixation is reduced. Placement positions have been found which enable the plant to obtain its nutrition quite as readily as if the fertiliser was generally distributed throughout the whole volume of soil around the roots. The principle underlying granulation is similar. One pound of superphosphate in granules of, say, 1 to 1.5 mm. diameter will expose much less surface area than 1 lb. of finely powdered superphosphate; each granule becomes the centre of a rich zone of steady phosphate supply, and plant roots actually concentrate themselves around these zones.



Here is a fine study of the ingredient hoppers in a fertiliser factory. Four are shown here, although when the picture was taken NPK mix containing only three ingredients (superphosphate, sulphate of ammonia and muriate of potash) was being produced. The single ingredients are fed down through the pipes on to a moving conveyor band and passed along to the mixing bin. Carried on the moving band the ingredients are shot into the bin in a series of layers which improves mixing. From the bin the mix passes to the conditioner. This photograph, like that on page 118, was taken at Lawes Chemical Co. Ltd.

Tests with cereal crops have shown that placement can reduce the amount of superphosphate required by as much as 50%. It is difficult to decide whether the similar claims of granular superphosphate have been proved as definitely, for in most of the measured tests with this form of material, placement has also been employed, and one cannot be certain whether the granular form or the placement has contributed most to the efficiency of the fertiliser dressing. It is not always possible, however, to adopt placement in applying fertilisers. In Britain and elsewhere the combine drill is the only general implement for placing a dressing, and the placement this drill provides is the row application of mixed seed and fertiliser. Unfortunately the seeds of some crops, *e.g.* roots, are damaged if they are combine-drilled, and even seeds that can tolerate intimate mixture with fertiliser can do so only if the rate of fertiliser application is below a very few hundredweights per acre. It must be admitted, therefore, that placement has limitations as a method for generally reducing the extent of soil fixation suffered by soluble phosphate.

Fertilisers resistant to fixation

Can new fertilisers which resist fixation be produced? Before discussing this possibility we must consider another aspect that may be irrelevant in theory but is extremely relevant in practice. The war and the post-war period have brought new economic difficulties. For every ton of superphosphates produced, rather more than half a ton of sulphuric acid must be used. For most of its history superphosphate has been relatively cheap to produce because the acid used has been plentiful, but now, with some abruptness, this situation has changed and there are big surpluses of sulphuric acid no longer. Moreover, the production of sulphuric acid is rising only slightly each year, but there is a steadily rising demand for phosphatic fertilisers. French and Italian scientists have assayed the use of nitric acid for treating phosphate rock, but this method has the disadvantage of producing calcium nitrate as well as soluble phosphate, which is difficult to handle after exposure to damp air.

That is, therefore, another reason for seeking new phosphatic fertilisers. There are two, or perhaps three, objectives which must be kept in view:

(1) To obtain a material whose phosphate content is less subject to fixation;

(2) To produce an available phosphate from phosphate rock without using sulphuric acid; and

(3) For some countries, to find a process which will use readily obtainable and non-imported substances for the treatment of phosphate rock.

A new phosphatic fertiliser could be successful if it fulfilled only one of these requirements; a fertiliser which satisfied all three may be too much to expect.

Silico phosphates

Some promising materials have already been developed, including fusion processes in which silica (with and without soda ash) is mixed with phosphate rock and, after high-temperature fusion, produces active phosphatic fertilisers. Towards the end of the recent war 'silico-phosphate' was made in a large-scale pilot plant in Kent; a somewhat similar product was manufactured on an experimental scale in East Africa. The fusion method is not entirely new, since it was developed in Germany during the first world war. The British silico-phosphate was about twice as concentrated as superphosphate and about three times as concentrated as average grades of basic slag. Tests showed that it was roughly as efficient as superphosphate (at the same rate of phosphate supply), while on acid soils a greater proportion of phosphate was taken up by the crop than

FACTS ON PHOSPHATES

Average yields of wheat, oats, and barley remove between 20 and 25 pounds of phosphoric oxide (P_2O_5) per acre (grain only).

Sugar beet and mangolds (roots only) take about 50 pounds of phosphoric acid per acre. Brussels sprouts remove 90 lbs. per acre, and cabbages and kale about 60 lbs. The average potato crop removes 50 lbs. of phosphoric acid per acre.

One hundredweight of superphosphate (18.0%) contains 20 lbs. of phosphoric acid. Compare the above figures of crop removal with this, remembering that at best only about a fifth of the phosphorus in the superphosphate will pass into the crop.

was the case with superphosphate. Unfortunately, the Ministry of Supply's experimental production was only temporary and further results have not been obtained. It is beyond dispute, however, that the materials needed are cheaper than the sulphuric acid used in superphosphate manufacture, but the costs of high-temperature treatment and the wear and tear upon plant may more than counter-balance this initial advantage. Silico-phosphate does not contain any water-soluble phosphate and it falls in the citrate-soluble class.

Triple superphosphates

Another line of approach is that developed by T.V.A. in the United States. This is based upon the conversion of phosphate rock into elementary phosphorus, a process requiring electric furnaces. Nearly 90% of the phosphorus in the mineral is extracted as phosphorus, which is subsequently burnt in oxygen or air to produce phosphoric oxide (P_2O_5), which on addition of water gives phosphoric acid. This acid is then used instead of sulphuric acid to treat phosphate rock, the resultant product being a very concentrated and mainly water-soluble phosphatic fertiliser, well known today as 'triple superphosphate.' A lesser-known T.V.A. fertiliser is calcium metaphosphate, which has been described as a kind of dehydrated triple superphosphate. In this process the vapour of phosphoric oxide, produced by burning elementary phosphorus, is allowed to act upon phosphate rock, the glassy material so produced being ground after cooling; the product, which is the 'metaphosphate,' is a very concentrated fertiliser. Both processes obviate the use of sulphuric acid and convert phosphate rock into an active fertiliser phosphate.

At one time it was believed that the T.V.A. methods were likely to remain unique. Cheap electric power seemed essential, and even then production costs were comparatively high. However, more concentrated products save bagging, transport and other handling costs, and where fertilisers have to be sent over long distances it is possible to offset higher production costs by economies in distribution. Triple superphosphate production will shortly commence in England. There is a great deficiency of phosphate in the soils of many of the tropical countries and it may be that this development will assist to meet the demand in the Colonial Dependencies. Proposals for the establishment of plant for treating phosphate ock by this process are also stated to be under consideration in connection with the new hydro-electric power scheme which is being developed on Lake Victoria in Uganda. So far as concerns soil fixation it has not been shown that these new phosphatic fertilisers suffer less fixation than superphosphate, but they have proved themselves to be effective fertilisers by current standards.

Another example of the effects of phosphoric acid on swedes. The rows which received no phosphate are on the left

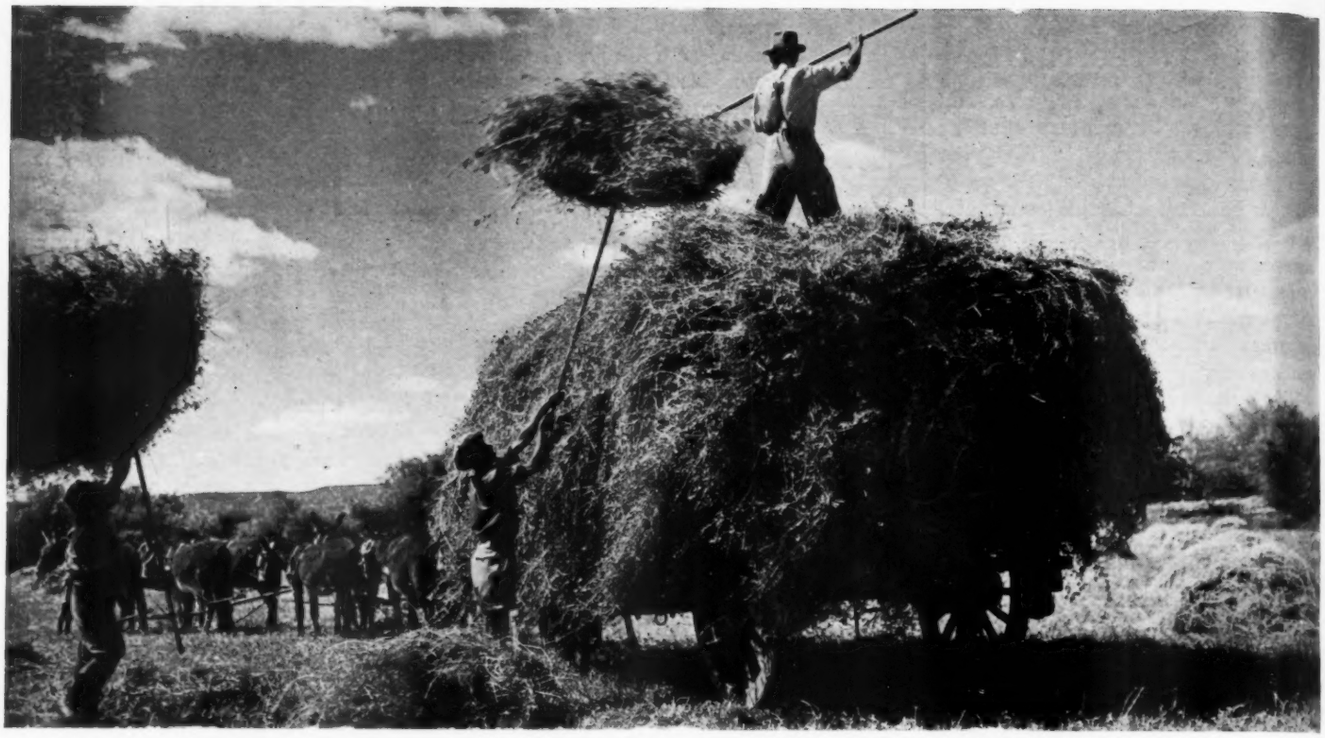
(This and the photograph on page 119 are reproduced from 'Phosphate and Superphosphate' published by the International Superphosphate Manufacturers Association)

It is probably true to say that new and fundamental research on the behaviour of phosphates (or phosphorus) in the soil is needed as a prelude to the development of fertilisers which do not lose so much of their available phosphate by fixation. The use of radioactive isotopes as a research weapon may open the way for progress indeed, this kind of investigation has already modified some of our older conceptions of phosphate uptake by plants. We can for the first time distinguish between the phosphate taken up from a fertiliser and that taken from the soil. It has been shown that in early growth wheat plants readily take up fertiliser phosphorus, but in their later stages they prefer to feed upon the soil's phosphorus. This must not hastily be regarded as a 'debunking' of the fertiliser idea. For the effect of the early intake of fertiliser phosphorus is that the plant is able later to take up more soil phosphorus than would be the case without the fertiliser phosphorus. At least this shows that we cannot hope to solve the phosphate problem by a chemical approach alone; the physiology of the plant must also be studied.

A very high rate of phosphate uptake (some two or three times as high as that of fertiliser practice) was achieved in some English experiments when cereal seeds were coated with a solution of phosphate and then dried. The limitation of this novel method would seem to be the very small amount of phosphate which can be supplied in this way.

In considering the wastage of effort and material that is caused by fixation, it must not be forgotten that phosphorus is not merely a plant nutrient—it is also one of the most important mineral nutrients of man and animals. If we could ensure that 50% of the phosphorus we applied to soils passed into crops and thence into our foods, we should make an enormous stride, not merely in crop production but in human health as well, seeing that phosphorus malnutrition is much more prevalent than is generally supposed.

NOTE.—Throughout this article the nutrient discussed has been referred to as 'phosphate.' This has followed the usual and popular practice, but there is no certain evidence that plants actually absorb their phosphorus in the phosphate form. It is more correct to speak of 'phosphorus' as the nutrient, but as this is seldom done in agricultural discussions it is apt to confuse the reader.



South African Silage Crops

Silage can be made from most cultivated plants, in fact, also from many weeds, but the quality of the silage produced depends in the first place upon the nature and the quality of the material ensiled. It is entirely impossible to make nutritious silage from plant materials of inferior feeding value. In the following article various silage crops, with methods of preparation, are discussed.*

THE composition of the green material used for silage varies greatly. First, it is influenced by the stage at which the plants are harvested. The younger the plants the richer they are in protein and the poorer in starch and sugar. Secondly, it is influenced by the kind of plant to be ensiled. Plants belonging to the grass family, such as maize, oats, etc., are comparatively rich in starch and sugar, but they are deficient in protein, while the legumes are rich in protein and deficient in starch and sugar. The first group of plants provides valuable feed for mature and dry animals, but as a group they provide too little protein for animals in milk or for young growing animals. On the other hand, the protein-rich plants provide the best feed for the latter group of animals. It is therefore necessary to take the type of animal which is to be fed into account when deciding the kind of silage crop to grow. Of course, the relative yields and the ease of harvesting the crop must be considered as well.

The following are the main groups of plants that can be used for making silage:

Plants of the grass family

In this group occur many of the well-known cultivated plants, such as maize, sorghum, millets and the winter cereals, and, in addition, both natural and cultivated grasses. As a group these plants are deficient in protein, but they are rich in starch and sugar, and, except when they are ensiled at an immature stage, they generally contain enough sugar for them to be ensiled without the use of additional sugar.

Maize

The maize plant is undoubtedly the most important silage crop in the world. In South Africa it is adapted to those areas having a summer rainfall of 22 in. per annum or more. In regions with a lower rainfall sweet sorghums are more suitable, as they are more drought resistant.

The best stage for cutting the crop for silage is when the grains start to become firm, *i.e.* the late dough stage, but if circumstances require it the crop may be cut earlier. Very young maize should be allowed to wilt for a day or so in order to get rid of superfluous water, which would give rise to a sour silage. Where maize has been killed by frost and has dried out excessively, water must be added in larger or smaller amounts, depending on the degree of dryness of the material to be ensiled. Under very favourable conditions maize can give yields of 50 tons of silage or even more per morgen (2.1 acres). Usually the yields are between 15 and 30 tons per morgen. In working out the area which should be planted to give the required tonnage of silage, it is safest not to put the estimated yield at more than 20 tons per morgen.

Sorghums

The sorghum group includes such crops as kaffircorn, sweet sorghums and Sudan grass. They are more resistant to heat and drought than maize and give better yields in the drier areas, as well as on poorer soils. When wilted these crops are poisonous for livestock on account of the presence of prussic acid, but when converted into silage there is no danger of prussic acid poisoning.

* *Abridged from 'Farming in South Africa'*

The stems of the ordinary kaffircorn varieties are relatively dry and consequently the crop is not so suitable for silage as maize. Still, if the crop is planted too late to ripen as a crop of grain, it can be successfully ensiled. Its nutritive value compares favourably with that of maize silage, particularly when cut in the late dough stage.

The sweet sorghums are very suitable for ensiling, but up to now the crop has not been used for the purpose as much as it should, especially in dry areas, where it grows well. The crop can be ensiled at as early a stage as flowering, but ensiling at the dough stage gives the best results. If cut at a very young stage it is necessary, as in the case of young maize, to allow the plants to wilt before ensiling.

Popular varieties of the sweet sorghums are the so-called Ambercane types and Wintersome.

Sudan grass can also be successfully ensiled, but, on account of the fineness of the stems, the crop tends to dry out rapidly during cutting and ensiling.

Millets

The fine-stemmed millets, such as Boer Manna, Japanese and Proso, are more generally grown for hay. Like Sudan grass, teff, sweet grass and other fine-stemmed hay grasses, these millets dry rather quickly during handling and ensiling, which makes it difficult to tramp down the ensiled material firmly and to exclude air properly. Usually it is necessary to add water, and heavy weights must be placed on top of the fodder mass to pack it down firmly.

Winter cereals

In the winter rainfall area of the Cape, winter cereals, particularly oats and barley, are the most important silage crops. On acid soils of fair fertility oats is the best crop, while barley is the best on soils inclined to be alkaline or brackish. On poor sandy soils rye is the best crop. Although wheat can be used for silage just as successfully as oats or barley, it is seldom sown for that specific purpose. Should a crop be killed by frost, or threatened by rust, it can be ensiled with advantage.

These crops can be cut for silage at any time from flowering to the dough stage. At these stages it is unnecessary to add molasses. Preferably the crops should be cut at the early dough stage, *i.e.* before the tips of the ears show any signs of colouring.

The winter cereals can also be ensiled at an earlier stage, but then the silage will tend to be sour and less palatable and it will be necessary to add 1 to 2% of molasses.

It is best to chop up these crops finely. Their stems are hollow and if the material is not chopped up it is not possible to exclude air thoroughly from the fodder mass, nor can it be well compacted. With this plant material special care must be taken to have the mass well tramped down.

The green material should be ensiled as soon as possible after cutting. It is seldom very sappy and if too much moisture is lost it is exceedingly difficult to exclude air from the mass effectively. The yields of silage from the winter cereal vary considerably. On stubble lands yields of 6 to 8 tons per morgen may be expected, while on fallow lands the yields should be from 12 to 15 tons per morgen.

Miscellaneous grasses

In addition to the cultivated grasses already mentioned, silage can be made from any other edible grass, whether cultivated or wild.

In the past it has been customary to conserve grasses in the form of hay, but adverse weather conditions frequently make it very difficult, or sometimes even impossible, to make good hay at the time when the grass is at its best, but under such conditions there is no trouble in making good silage. The plants are to be sown at the correct stage and ensiled to give a high quality conserved feed.

Among the various grasses which have been brought into cultivation are Napier fodder (elephant grass), Nile grass (*Acroceras macrum*), the Panicum group, of which the Makarikari strain has been the best, the Setarias, of which du Toitskraal, Kazangula and Kabulabula are the most important strains, and *Paspalum urvilli*. Under favourable conditions these grasses can yield crops which vary from 20 to 30 tons per morgen. Mention must also be made of Rhodes grass (*Chloris gayana*) and *Paspalum dilitatum*, which can yield 15 to 20 tons of green fodder per morgen.

In addition, there are the various wild veld grasses, the yield of which will vary, depending upon whether their habitat is a tall grass or a short grass region. Grasses from tall grass regions can easily yield up to 15 tons per morgen with two cuttings. All the grasses listed are perennials and they have the following advantages over annuals :

1. Since these grasses are of a permanent nature, they promote soil fertility and protect the veld from water and wind erosion as well as from desiccation.
2. The costs of maintenance of such grasses are low, since annual ploughing, sowing and cultivation are eliminated.
3. In most cases two crops can be harvested each year and still have some aftermath grazing.
4. Perennial grasses are generally less subject to diseases and pests, and they recover sooner after being damaged by hail.
5. Generally the yields are more consistent.

Most grasses are fine stemmed and dry out quickly after cutting. There must therefore be no delay in ensiling such green fodder after cutting. With the exception of coarse-stemmed grasses, such as Napier fodder, they may be ensiled without being chopped up.

Plants of the legume family

Many of the most valuable fodder plants, such as lucerne, clover, vetches, cowpeas and soybeans, are legumes. As they are rich in protein, they are of particular value for the livestock industry. It is a well-known but deplorable fact that in South Africa not nearly enough protein-rich fodder is produced to meet the requirements of the animal population. In this respect the shortage can be largely met if farmers will only apply themselves to the production of protein-rich fodders and conserve it for the scarce season in the form of hay or silage.

Silage making with legumes is not as easy a matter as with grasses, for legumes are deficient in sugar and the preserving lactic acid cannot be formed sufficiently quickly or in sufficient quantity to prevent spoiling of the silage. This sugar deficiency, fortunately, can easily be met by the addition of sugar in one form or other during the process of ensiling. This can be done in two ways: either by adding sugar in some cheap form, such as molasses, or by ensiling the legumes with one or other sugar-rich plant in the proportion of *one to two or one to one*. When this is done there is not the slightest reason why high quality silage cannot be made from legumes.

Lucerne

Lucerne is grown mainly under irrigation in the Union, and in most cases is used for grazing and hay making. In some parts of the country, especially the South-Western Cape, it is being increasingly grown as a dry-land crop and is used primarily for grazing.

Where climatic conditions render hay-making a difficult and risky business, or where protein-rich succulent feed is required, lucerne can be conserved as silage with great advantage.

The best stage for ensiling is that when 10 to 30% of the crop is in flower. The crop is mown down and immediately raked and carted to the silo.

Since the stems of lucerne are fine, the crop can be ensiled without being chopped

up, but the best quality silage is made when the material is chopped up.

Because of its sugar deficiency, lucerne must be ensiled with molasses and 4% should be added.

Cowpeas and soybeans

These are two of the most important crops that can be grown for silage in the summer rainfall area. They can be grown successfully where maize does well. Owing to its resistance to drought, the cowpea is well adapted for cultivation in the drier areas, while soybeans answer very well in summer rainfall areas with a rainfall of 25 in. or more. The soybean is not subject to rust and does exceedingly well both in the mist belt and in the warm Lowveld areas, where the rainfall is adequate or where irrigation is possible.

Weeds can usually be well controlled by eradicating at least two flushes of weed growth by cultivation prior to seeding.

The upright-growing cowpeas are the most suitable for silage, for, like soybeans, they can be cut with either a mower or a self-binder. The prostrate kind of cowpeas have to be spaded off, which is a distinct disadvantage where labour is scarce and expensive.

Soybeans must be cut as soon as the pods are well formed, but before the leaves begin to yellow. Cowpeas must be reaped as soon as the first pods are well filled.

If these two crops are ensiled in the correct way, they will furnish a silage of excellent quality.

Velvet beans and dolichos beans

In the warmer summer rainfall areas, such as the Lowveld and Southern Natal, these two crops thrive particularly well and generally give higher yields than cowpeas or soybeans. They have the further advantage that they do not shed their leaves early and can be left on the land for a longer period before cutting. The farmer can therefore delay harvesting until weather conditions are favourable.

They are excellent crops for silage, but have the disadvantage that, being prostrate in growth habit, they must be harvested by hand.

The best stage for cutting the crops for silage is when the first pods are well filled. For the rest the procedure for ensiling them is the same as that for the other legumes.

Sunn hemp (Indian hemp)

Sunn hemp is pre-eminently a crop for the warmer parts of the summer rainfall area, but for silage purposes it can also be grown with success in the Highveld. It does reasonably well on poor soils, is fairly drought resistant and on dry lands yields good crops provided the rainfall is 20 in. or more. The crop grows very quickly and is excellent for smothering weeds.

[*Photo: Courtesy Silorator Ltd*

A pit silo being filled by means of the new Norwegian method *

The best time for cutting Sunn hemp for silage is at the early flowering stage. The plants are then not too fibrous and a silage of high nutritive value can be obtained. If cut later, the plants contain too much fibre, which lowers their feeding value.

Sweet lupines and serradella

These are two less well-known legumes which are valuable for silage making and which, being cool weather crops, are particularly adapted to the winter rainfall area.

In contrast to most other legumes, they prefer sour soils and give very good results on poor sandy soils.

Both ' sweet ' and bitter lupines occur. While sheep may graze the bitter lupines, this type cannot be recommended for silage because of the bitter taste. The sweet lupine and serradella, however, can be turned into silage of excellent quality.

To ensure success with these crops the seed should be inoculated with the correct strain of nodule bacteria.

When the crops grow well they give high yields of green material and a yield of 30 to 40 tons per morgen from lupines is nothing unusual.

Lupines can be cut as soon as the seed of the main flowering stem is well formed. Even then the crop is still very succulent and it should be allowed to wilt before ensiling. As the lupine stems are somewhat thick, the crop should be chopped with the silage cutter.

Serradella can be cut as soon as the first pods are well formed. Since the stems are very fine, it need not be chopped up.

Vetches

Exceptionally fine silage can be made from vetches. In addition to the cultivated types, there are wild types (commonly known as ' wilde-ertjie '). Both the cultivated and wild vetches are suitable for silage. Since vetches have a prostrate growth habit, they are usually not sown alone, but in mixtures with winter cereals, especially oats.

There are two main varieties of the cultivated vetch which can be grown for silage, namely, hairy vetch and purple vetch. The latter is a quicker grower and is more popular.

The crop can be cut at any time when the oats have reached the flowering to soft dough stage and the green material should be passed through the silage cutter.

It is a good practice to mix legumes with other plants rich in sugar. Such mixing gives a better balanced silage and, provided the crops are cut at the correct stage and ensiled in suitable proportions, it is unnecessary to add sugar.

Examples of useful mixtures in the summer rainfall area are maize or sweet sorghums, with cowpeas, soybeans, velvet beans, dolichos beans or lucerne.

The crucifers (cabbage family)

The crucifers are used mainly as green feed when fed to livestock. They are rich both in protein and in carbohydrates (starch and sugars). Still, if circumstances de-

* *See Editorial note on Ensilage, p. 93*

Farm workers filling a portable silo of the type commonly used in England

mand, they can be ensiled successfully, especially when mixed with less succulent green material. As the plants are rich in sugar, no addition of sugar is needed during ensiling.

Silage made from crucifers decays more rapidly than maize silage after removal from the silo, and no more should be taken out at a time than can be consumed in one day.

If this kind of silage is fed to cows during or immediately before milking, the milk becomes tainted.

There are two species of crucifers of importance as animal fodders, namely, kale and rape.

Kale

Kale does best under cool, relatively moist conditions. In those parts of the winter rainfall area where the rainfall is comparatively high the crop can be planted on the hills and slopes. In drier areas it must be planted in low-lying deeper soils if it is to survive the summer.

Kale can be ensiled alone, but, because of its high moisture content, much sap will drain down to the bottom of the silo, and if the silo is watertight much of the silage below will become excessively wet. Much better results are obtained by mixing kale with equal amounts of oats or other green material which is not so succulent, or which has been allowed to wilt.

There are two varieties of kale generally cultivated, namely, ' Thousand - headed Kale ' and ' Chou Moellier.' The latter is the better variety.

Rape

Like kale, rape is also a cool weather plant. It is very resistant to cold and thrives in areas where the winters are not excessively severe. In contrast to kale, whose leaves are picked and fed, rape is used for grazing. Heavy fertilising as for kale is advisable.

Miscellaneous crops and other plant material

In addition to the crops already discussed, silage can be made from many other crops, as well as from weeds and other waste products.

Sunflowers

This crop is often selected for silage purposes in place of maize because of its resistance to drought, frost, damage by locusts and witchweed. On poor soils it also gives bigger yields than maize. When well made, sunflower silage has much the same feed value as maize silage.

But the crop has certain drawbacks. The stems are very rough and when a considerable amount is handled the labourer's hands suffer. Although the plant is more frost resistant than maize, a heavy frost will render sunflowers unsuitable for silage, while maize can still be utilised. Sunflowers again are hard on the soil and cannot be grown continuously on the same land. Sunflowers are also very susceptible to eelworm and can only be grown successfully on land which is not infested. Sunflower silage has an unpleasant smell and is not very palatable. Only when animals become accustomed to it will they eat it readily.

The crop can be cut for silage when 10 to 75% of the plants are in flower and before seed has formed. Later cutting will give too fibrous a silage with reduced nutritive value.

Because of the coarse stems sunflowers must be chopped up during ensiling, otherwise air will not be thoroughly excluded. The palatability of sunflower silage can be improved, and the success of the process ensured if it is ensiled in a mixture with maize, sweet sorghums or other sugar-rich plants, or, failing them, by the addition of 1 to 2% molasses.

Artichokes (Jerusalem)

This crop is related to sunflowers, but it is perennial and bears tubers in the ground. The tubers are greatly relished by pigs, while the foliage can be utilised for making a fair quality silage.

Soon after the plants have finished flowering the tops may be cut and ensiled, while the tuber crop is left in the soil for pigs to root out for themselves.

Potatoes and potato tops

In certain European countries silage is often made from surplus or waste potatoes. They may be ensiled either raw or steamed. In all cases the soil must be washed off before ensiling.

In steaming, special equipment which simultaneously washes and steams the potatoes is generally used.

After steaming the potatoes are thrown into the silo and tramped down. Silage prepared in this way is of very good quality and greedily eaten by all types of livestock.

Raw potatoes should preferably be ensiled together with other fodders, and the mixture be chopped up by the silage cutter. Any quantity of potatoes can be ensiled in the mixture, but when ensiled in mixtures containing less than 75% of protein-rich plants it is unnecessary to add sugar.

Silage made exclusively or mainly from potatoes is a feed rich in starch and consequently is excellent for fattening livestock.

A fairly good silage can also be made from potato tops. The tops should not be too young, for there is the possibility of their containing solanine, which may be harmful to livestock.

The best stage to ensile the potato tops is when they begin to turn yellow. The foliage contains considerable protein and if ensiled alone it is necessary to add 2 to 3% molasses. Alternatively, it can be ensiled with maize or sweet sorghums in equal proportions.

Miscellaneous materials for silage

Certain miscellaneous plants, such as buckwheat and linseed, the tops of palatable plants, such as mangels and potatoes, and certain weeds, such as khakibos and cos-

mos, may be ensiled in mixtures with maize and sweet sorghums. Owing to the danger of possible poisoning from buckwheat and linseed, the quantity of these plants included in the mixture should not exceed 10%.

In the winter rainfall area good silage can be made from winter volunteer plants, such as charlock or wild radish, cranesbill and annual winter grasses.

Finally, waste products, such as pea pods and vines, are sometimes available in the neighbourhood of canning factories. Such materials can be used for silage with advantage, but the addition of 2 to 3% molasses is needed to give a really good silage.

Mobile Silage Machine

The preservation of the nutritive value of home-grown fodder is now generally recognised as most important; great quantities are lost, up to 60% protein, if, for instance, hay-making is carried out under adverse weather conditions.

One of the most important problems of agricultural production is the preservation of these nutrients and, since this problem is now receiving the attention it deserves, the use of artificial drying and ensilage is spreading. In England the " Robust " Universal Cutter and Chopper Up, shown in the photograph below is being widely used by farmers with good results.

Its advantage lies in the fact that fibrous fodder and root crops are disintegrated in one operation, either singly or mixed, and are reduced to the size required for drying and ensiling or for the daily green feed.

It is a great advantage that fodder of high protein content can be mixed and ensiled with fodder of a high sugar content.

The machine is also used to great advantage for the breaking down of the fibrous parts of straw, ensuring thereby the better and quicker putrefaction of organic manure in the soil.

Compressed Air Power on the Farm

THE first complete demonstration of its kind in Great Britain, showing the manifold uses of compressed air power on the farm was held recently at the Home Farm, Eynsford, before representatives of the Ministry of Agriculture, the agricultural press and the B.B.C.

Mr. William Alexander, proprietor of the Home Farm, had kindly provided full facilities on the farm for a large number of demonstrations. The first was limewashing of a large cowshed with a mobile compressor set, the H.P.S.2 and three lances. The visitors were then shown spraying of ' Snowcem ' (normally regarded as too viscous for spraying by compressed air). Using a H.M.S.12 compressor set with pressure feed container, operating two full-capacity spray guns, one side of a small cowshed was completely sprayed with ' Snowcem ' in a matter of minutes. This was followed by the preparation of brickwork for cement rendering by air hammers, again using the H.M.S.12 compressor set.

The use of compressed air in inflating tractor tyres was then shown, as also the blowing out of tractor radiators to clear them of dirt and insects which might otherwise cause the tractor to overheat.

Spraying of unthinned gas tar on a tractor shed was carried out in a few minutes by means of a H.M.S.12 compressor set with 6-ft. extension arms to the spray guns.

There was creosote spraying of the end of a large shed, which was completely sprayed by means of 8-ft. bamboo lances, using a new Hymatic compressor set—the H.M.S.7/P. This job was completed in 15 minutes, but by hand methods it would have taken a full day. Red oxide paint spraying and rust-killer paint spraying on sheds in the cattle yards then gave a touch of colour to the demonstration.

This was followed by the sharpening of reaper and binder blades with a pneumatic drill with grinding wheel attachment.

Of special interest to fruit growers was the tree spraying with horticultural solutions from a mobile H.P.S.2 compressor set, followed by powder blowing with the new Hymatic portable powder blower operated from the same H.P.S.2 compressor.

It is interesting to note that all these jobs were completed within four hours. This indicates the tremendous saving of time, which is the natural corollary of the use of compressed air power. The demonstration was carried out by the Hymatic Engineering Co. Ltd. of Redditch.

THE CONSERVATION CONFERENCE AT LAKE SUCCESS

A Step Towards the Mobilisation of World Resources

In our October issue a short account was given of the opening sessions of this important conference. Below we reproduce a fuller report of the proceedings. The conference must be regarded as of great significance inasmuch as it represents the first step taken by the United Nations to promote higher standards of living, through the mobilisation of the scientific resources of the world.

THE United Nations Scientific Conference on the Conservation and Economic Utilisation of Resources was held at Lake Success from August 17 to September 6. The conference was called upon the suggestion of President Truman; it was the first scientific meeting sponsored by the United Nations and was probably the most ambitious of its kind ever undertaken. Its object was to review world resources and the application of science to the task of raising the living standards of a rapidly growing world population.

It may be regarded as an essential preliminary to the formulation of the programme of technical assistance to the under developed countries which the United Nations is organising to implement the President's Fourth Point. It brought together over 600 scientists and technicians from 49 different countries to discuss the outstanding problems in the six main fields of development, viz.:—land, water, forests, fuel and power, minerals, fish and wild life. There was a series of plenary sessions attended by all groups at which the interrelationships of the various aspects of the work and the broad general considerations were discussed, while sectional meetings were also held at which papers dealing with the specialist problems of each group were considered.

In a brief welcoming address, U.N. Secretary-General Lie emphasised the importance of resource development to the building of enduring peace. He described the conference as one of the first steps in the U.N.'s programme of technical assistance to underdeveloped countries.

Development of backward areas

In the main address at the inaugural session, U.S. Secretary of Interior J. A. Krug, warned against underrating the force of the widespread desire for higher standards of living. ' It is one of the major facts of this century,' he declared. ' It crosses national boundaries. It pervades groups in all communities. It is dynamic. It pushes organisations and governments into action.' He urged the necessity of co-ordinated development of agricultural and industrial resources, remarking that ' ten dollars of development in one year are frequently worth twenty scattered over ten years.'

The American cabinet minister pledged anew that the U.S. would help in the development of backward areas, but indicated at a press conference later in the day that official U.S. aid would be limited to participation in exploratory surveys. The bulk of American aid would come from private investors, who, Secretary Krug said, were ready to invest the astronomical sum of three hundred billion dollars abroad if the ' institutional climate,' including the political atmosphere, were right. The Australian economist Colin G. Clark told the conference that afternoon, however, that American savings were declining and that comparatively little private American funds would be available for financing developments overseas.

Productivity on the farm

Mr. Clark, who is economic director of the Queensland Bureau of Industry, made his observation in the course of an extensive analysis of the world food problem. He began by pointing out that man-hour productivity on the farm can rise at a rate of 1½ per cent. per year, as against an annual world population increase of 1 per cent. On the face of it then, the per capita food supply can be increased and the problem of feeding the world is beaten. But four important factors militate against this actually being accomplished. These are : (1) a disproportionate rise in consumption by the farmer as his real income rises ; (2) overcrowding, which makes it impossible to hold the annual 1½ per cent. productivity gain ; (3) decrease in hours the farmer is willing to work ; (4) the flight from the land in many parts of the world.

Of the four, the last, in Mr. Clark's opinion, is the most important. The drop in rural population, he said, is taking place in nearly every country and ' shows every sign of continuing, and, indeed, accelerating.' As might be expected, it is most rapid in economically advanced countries. ' Within the United States it is found that the loss of agricultural labour is most rapid in the now industrialised middle-western states, where productivity per head in agriculture is also high ; there is a less rapid loss of labour in the less productive southern states. . . . It is not the law of diminishing returns or the lack of agricultural areas for cultivation which has caused the world food shortage, and which may cause a worse shortage in the future ; it is the lack of labour.'

The Australian economist attributed the flight from the land to increased urban employment opportunities and the poor return of farming. ' Up to now we have been fed by the underpaid labour of peasants and agricultural labourers throughout the world,' he continued. ' The older generation expected this state of affairs, but . . . a new generation of countrymen is now growing up throughout the world who are not prepared to remain at their work unless they see in it economic opportunities comparable to those of the urban population.' To keep labour on the land, the prices of farm commodities must be allowed to rise substantially,

relative to the prices of manufactured goods.

Mr. Clark predicted for the next decade that relative crop prices would actually rise to 70 per cent. above the 1925-34 level. A further slight rise is to be expected between 1960 and 1970. In 1960, he also predicted, the per capita supply of farm products would equal the supply in 1935, except in Russia, Eastern Europe, Eastern Germany and China, where it would be about 1 per cent. greater.

Mr. Clark was preceded at the afternoon session by Fairfield Osborn, president of the New York Zoological Society and a widely known American conservationist. Mr. Osborn warned that new lands can no longer be depended upon to take care of increases in world population ; only certain tropical and very northerly regions are left. On the other hand, he pointed out, the productive capacity of the earth, given intelligent management, is great enough to avoid the calamitous shortages recorded throughout history.

In the course of the debates many important points were raised. Dr. John Hammond of the University of Cambridge drew attention to the importance in agricultural development of tropical and semi-tropical grass lands and to the need for a research station which would do for pastures under these conditions what has already been done by research stations for arable farming.

Fertiliser resources

A review of the mineral resources of the world showed that resources of potash, phosphates, and coal are all good for many hundreds of years at our present rate of consumption, so that with the fixation of atmospheric nitrogen by using coal, the future of the world's agricultural economy is secure in its resources of fertilisers.

On the closing day of the conference a speaker from each section summarised the main outcome of that part of the work. It was an impressive review of progress already made in each field and of the prospects for the future. The conference was wisely instructed not to formulate resolutions in the first meeting of this kind. Its purpose was the exchange of information and experience from which in the course of time conclusions can be drawn.

Conference results

What are the results of the Conference ? In the first place it has brought together for the first time groups of outstanding specialists in different fields from almost every country and has enabled the establishment of new contacts and the exchange of ideas between members which may be expected to bear invaluable fruit in the future. Secondly, and even more important, it has helped to crystallise and clarify ideas as to what is possible and what is not, and of the requisites and limitations governing the aims in view.

Even supposing that everything suggested in the conference were done to raise the efficiency of production, particularly in the undeveloped countries by technical assistance, by capital investment, by providing equipment, by water control and irrigation, by opening up new areas, and by a measure of industrialisation, there would still remain the human problem, the necessary changes in the life and outlook of many millions of people. This was

Secretary General Trygve Lie chatting during recess with Konstantin Zinchenko of Russia an assistant U.N. Secretary General

not forgotten, and emphasis was laid on the need to keep human progress in step with technical progress, without which the latter would be ineffective.

Particular stress was laid upon the necessity of having adequate backgrounds of facts and data upon which to work. Clearly the work of the Economic and Social Council in helping to implement President Truman's Fourth Point by technical assistance to backward countries should have a factual background. Speakers emphasised the need for national surveys of resources, and for their availability so that all might be better able to judge what is possible. There seems a clear case for the United Nations to act as a focus and a clearing house for such surveys.

Delegates in attendance

Countries represented at the conference included Finland and Yugoslavia, but not the U.S.S.R. or any of the countries directly within the Soviet orbit. Poland and Czechoslovakia contributed, however, to the 476 papers prepared for the daily section meetings on land, fish and wildlife, forest, water, mineral, and fuel and energy resources. The U.K. sent a delegation of 26. Headed by Sir Harold Hartley of the World Power Conference, it included G. F. Clay, agricultural adviser to the Secretary of State for Colonies; A. M. Duckham, agricultural attache at the British Embassy in Washington; Michael Graham, Fisheries Laboratory, Lowestoft; John Hammond, reader in agricultural physiology at the University of Cambridge; Isabella Leitch, director of the Commonwealth Bureau of Animal Nutrition; J. MacDonald, of the Forestry Commission; V. K. Maitland, forestry and soil conservation adviser, British Middle East Office; Sir William Ogg, director of agricultural research at Rothamsted; Lord Robinson, chairman of the Forestry Commission; L. Dudley Stamp, of the University of London; and F. N. Woodward, director of the Scottish Seaweed Research Association. Canada sent 26; India, 12; South Africa, 5; Australia, New Zealand and Pakistan, 2 each; and the British West Indies, 1. Delegates came as individuals rather than as official representatives of governments.

New Oil-fired Grain Drier

A NEW phase in grain drying was entered recently at a demonstration given at the Southampton factory of the Wells Agricultural Group, Ltd., of an oil-fired adaptation of their electric grain drier.

At the demonstration wheat grain was passed through the drier at the rate of 15 cwt. an hour. A test of the grain before it passed through the drier showed a moisture content of 24% ; on leaving the drier the same test showed a moisture content of 16½%. This appeared to be an extremely good extraction. The results were taken over an average of three tests.

The benefit of oil firing was stated to be (*a*) economy in costs, (*b*) elimination of the risk of overloading of electric wiring on farms not wired for such heavy equipment. The grain drier is semi-portable and takes about 10 minutes to warm up to capacity drying.

Good points : Compact and semi-portable ; economical to run ; good extraction.

Bad points : Noisy in operation; grain feeder and receiver (2½cwt.) too small to keep drier supplied without constant attention.

Locust Destruction in South Africa

THE recent seasonal review of locust destruction in South Africa disclosed that conditions were exceptionally favourable for the rapid increase of locusts in general and, as a result, extensive campaigns were conducted in 26 districts against incipient outbreaks of the brown locust, while swarms of the desert locust had to be destroyed in two districts. In the swampy areas of the Bechuanaland Protectorate, the tropical migratory locust increased to critical densities. The International Red Locust Control Service conducted campaigns inside as well as outside the known outbreak-areas of the red locust in Central Africa. In all these destruction campaigns a great measure of success was attained and it can be stated that agriculture suffered no losses as a result of locust ravages.

In the previous review it was forecast that, according to counts of locust population densities, incipient outbreaks could be expected in 13 districts, all of which are situated in the medium and higher-rainfall zones of the outbreak region.

Broadly speaking, forecasts of outbreaks of the brown locust are based on the level of the locust population and the expectation of normal rainfall in each particular district. Other factors militating against correct forecasting are that scattered flying locusts migrate to some extent and that all brown locust eggs can lie dormant for long periods during droughts.

The Desert Locust

Up to the present season no swarms of this species had occurred in the Union, South West Africa or the Bechuanaland Protectorate since May 1939. As a result of unusually good rains during the second half of the summer, the solitary population bred up to critical densities, and 419 hopper bands were destroyed in the districts of Gordonia in the Cape Province and Karasburg in South West Africa. Control measures were also applied against flyers of this species which were doing damage in irrigation settlements at Vioolsdrift on the Orange River.

A 40% benzene hexachloride wettable powder, dissolved in water, was again used with great success against the flyers

A typical gang working in young plant cane with a weak solution of arsenic to kill young locusts

densely settled in bushes for the night.

The Tropical Migratory Locust

This species has only been known to occur in the Union in the swarming phase on one occasion. That was in 1932-33. In 1933-34 they were often found associated with swarms of other species, notably the red locust. Scattered adults of this species were found in certain parts of South West Africa, notably at Swakopmund on the west coast. The situation is being kept under close observation in order that steps can be taken to control outbreaks if necessary.

The Red Locust

The red locust situation in Central Africa was extremely grave after the conclusion of the hopper campaigns in the Rukwa outbreak-area during 1946-47. Nevertheless a last attempt was made to save the situation, and extensive campaigns were internationally planned and carried out during 1947-48 in both outbreak-areas, Rukwa and Mweru Wa'Ntipa, as well as in the infested areas outside the known outbreak-areas. In the operations in the two known outbreak-areas, two senior locust officers and 14 locust officers from the Union participated.

One method of catching the hoppers is to erect corrugated iron fences at the edge of sugar cane fields. At the bottom of the fences are placed poisoned molasses

To reduce the number of flying swarms before the commencement of the breeding season in the Rukwa Valley, an experimental air-spraying campaign was organised. The destruction of adults by this method not only rendered it possible to gather valuable scientific data, which has since been published, but also undoubtedly caused a significant reduction in the scale of subsequent hopper campaigns.

Both within and outside the outbreak-areas, the result of the hopper campaigns was gratifying and consequently the red locust situation is now more favourable than at any time during the past five years.

Farm Machinery Demonstrated by Ford's

A FIELD demonstration was given by the Ford Motor Company at Cranham in Essex on September 20, at which the operation of a large number of cultivators and equipment was demonstrated and an exhibition staged illustrating the training scheme operated by this organisation.

Altogether 49 different types of equipment were demonstrated in the field, including both machinery attached to the tool bar and towed implements.

The appliances exhibited included various types of ploughs, cultivators, harvesters, planters, transport boxes, drainage machines, winches, excavators, bulldozers, tippers and spraying machines, and included not only machinery manufactured by the Ford Company themselves but also by a number of other undertakings whose implements and machinery have been adapted for use with the Fordson and the Fordson Major Tractor.

The educational exhibits illustrated the manner in which the Fordson Company have developed the idea that industry should play an active part in the broad educational developments as well as the vocational training of young students; among the various branches illustrated were the Trainee Scheme, the Trade School, the Facility Schools and the Scholarship Plan. After the demonstration, those present were given the opportunity of visiting the new Service Facility School at Dagenham and of seeing the instruction in progress.

The demonstration was well attended and provided visitors with an opportunity to see in operation the extremely wide range of uses to which the tractor can be put with the aid of modern development in machinery design. We hope to include a fuller account of the demonstration together with illustrations of some of the machinery exhibited in the December issue.

The Ford Service Facility School at Dagenham, Essex

World Tobacco Production Increases

THE world's tobacco harvest during the twelve months July 1948 to June 1949 is estimated at 7,453 million lb., as compared with 1947-48 production of 7,315 million lb. and the pre-war (1935-39) annual average of 6,597 million lb. The data for 1948-49 and 1947-48 are revisions from estimates released in November 1948. For both years the harvest is slightly larger than previously reported.

Production in 1948-49 in the United States and some other countries is well below 1947-48 harvests, but declines in these areas are more than offset by increases in China, Canada, Brazil, the Philippine Republic and several other countries. The world crop is estimated at approximately 2% above the 1947-48 output.

The 1948-49 production of flue-cured leaf, the principal type entering world trade, was about 18% below the large 1947-48 output. The sharp reduction of about 228 million lb. in the 1948 United States' crop, however, has been partly offset by a record crop in China. Substantial increases in flue-cured production were also made in Canada, Brazil, India and a number of other countries.

The production of Oriental or Turkish type tobacco in 1948-49 is estimated to be somewhat below the 1947-48 crop. Larger crops are reported from Bulgaria, the U.S.S.R. and Yugoslavia, but reductions in Greece and Turkey are expected to more than offset the increases reported for these countries. The relatively small production in South Africa and other parts of the world is estimated to be about the same as in 1947-48.

The 1948-49 world production of light air-cured types of tobacco which represent an important portion of total production in many producing countries, is estimated to be somewhat larger than in 1947-48. The production of cigar types and other dark types also is estimated to be larger in 1948-49 than in 1947-48.

North America

Canada's 1948 tobacco production is now officially estimated at 126.6 million lb., as compared with 106.7 million lb. in 1947. The acreage harvested in 1948 was 12% below 1947, but the average yield per acre was 34% higher. The United States' crop is officially estimated at 1,982 million lb. from 1,555,000 acres, as compared with 2,110 million lb. from 1,853,000 acres in 1947 and an annual average of 1,460 million lb. from 1,647,000 acres in the pre-war (1935-39) period. The

1948 production of flue-cured, fire-cured and dark air-cured types show substantial declines from 1947 levels. The production of light air-cured leaf was 22% larger in 1948 and the production of cigar leaf was about the same as in 1947.

The 1948-49 production in Mexico, Central America and the Caribbean countries is estimated to be about 10% larger than in 1947-48. Increases are reported for Mexico, the Dominican Republic and most Central American countries.

For all North America, the 1948-49 production of tobacco is estimated at 2,320 million lb. from about 1,990,000 acres, as compared with 2,410 million lb. from 2,260,000 acres in 1947-48 and a pre-war (1935-39) annual average of 1,710 million lb. from 1,960,000 acres.

Europe

The 1948 production of tobacco in Europe, excluding the U.S.S.R., is now estimated to be about 9% larger than the 1947 crop. Sharp increases over 1947 are reported for Bulgaria, Czechoslovakia, Hungary and Poland, and moderate increases for Rumania, Spain and Switzerland. A sharp drop in production is reported for Belgium and some decline for France, Greece and Italy. The total 1948 production in Europe is estimated at 810 million lb. from about 925,000 acres, as compared with the 1947 harvest of 745 million lb. from 825,000 acres and the pre-war (1935-39) annual average of 675 million lb. from 680,000 acres.

U.S.S.R.

Authentic information on tobacco production in the U.S.S.R. in recent years still is not available. Unconfirmed reports still indicate an output in 1948 somewhat above the 1947 crop, but approximately 8% below the pre-war average production of about 525 million lb.

Asia

Turkey's 1948 tobacco crop is estimated at 176.4 million lb. as compared with the 1947 production of 220 million lb. In the Asia Minor countries of Iran, Iraq and Israel, which produce Turkish-type leaf, the 1948 production is estimated to be below the 1947 output. The 1948-49 tobacco harvests in most Far Eastern countries are reported to be above 1947. Larger crops are reported for China, Japan, Korea, Taiwan (Formosa), Indonesia and the Philippine Republic. For all of Asia, 1948-49 harvests total 3,315 million lb. from about 3,720,000 acres, as compared with 3,175 million lb. from 3,730,000 acres in 1947-48 and the pre-war (1935-39) average of 3,250 million lb. from 3,750,000 acres.

South America

A slightly smaller acreage was planted to tobacco in 1948-49 in South America, but total production is reported to be somewhat larger due to more normal yields than were obtained in 1947-48. Combined 1948-49 production of tobacco in all South American countries is estimated at 415 million lb. from about 450,000 acres, as compared with 395 million lb. from 460,000 acres in 1947-48 and the pre-war (1935-39) average of 305 million lb. from 355,000 acres.

Africa

The 1948 harvest in northern African producing countries is estimated above 1947 crops, due primarily to higher yields as a result of more favourable weather during the season. Harvests in southern African producing countries are estimated to be about 13% below 1947-48. The reduction was due to decreased yields in 1948-49, which resulted from a prolonged drought during the growing season.

The combined 1948-49 production of tobacco for all of Africa is estimated at 200 million lb. from about 395,000 acres, as compared with 213 million lb. from 395,000 acres in 1947-48 and the pre-war (1935-39) average production of only 125 million lb. from 245,000 acres.

Blister Blight Disease. The photograph on the right (Fig. 2) shows how the lesion envelops the young shoot which will eventually die back The photograph on the left (Fig. 1) shows the effect of the disease on the reverse side of the leaf

Recent Advances In Tea Research

T. EDEN, D.Sc., A.R.I.C.

Director Designate of the East African Tea Research Institute

II—Pathological Problems

This is the second of the series of articles on tea research, the first of which appeared in the October issue of this journal. It deals with the pests and diseases which attack the crop and, incidentally, gives an account of the 'blister blight' disease which has caused much concern in Ceylon and Southern India of recent years. The third and final article dealing with maufacturing problems will appear in the December issue.

THE tea crop has not until recently been seriously affected by widespread plant diseases and pests. There have constantly been localised infections of root disease, such as *Poria hypolateritia, Ustulina zonata, Rosellinia arcuata, Fomes noxius* and *Armillaria mellea.* Leaf and stem diseases, with the exception of Blister Blight, have been of only moderate importance. Insect pests have been sporadic in incidence, the more serious being due to Mosquito Blight (*Helopeltis antonii*), Tea Tortrix (*Homona coffearia*), Shot-hole Borer (*Xyleborus fornicatus*), and a number of mites. There are, in addition, a virus disease, a physiological disease, due to sulphur deficiency and a troublesome eelworm (*Pratylenchus pratensis*), all of which are potentially serious, but Blister Blight is by far the most devastating in range.

The descriptions that follow are restricted to a representative selection of those pathological problems upon which intensive research has been carried out.

Blister Blight (*Exobasidium Vexans*)

Blister Blight was recorded in North-Eastern India as early as 1858 and has been spasmodically encountered ever since. Severe attacks occurred in Darjeeling in the first decade of the century, but thereafter its incidence has been casual in North-Eastern India. Despite long-standing regulations restricting the movement of seed, the disease made its way to Southern India and Ceylon late in 1946 and has since been reported from Sumatra. In Southern India and Ceylon the virulence of attacks has been far greater than in North-Eastern India. All montane districts have been seriously affected and the persistence of the disease has caused much perturbation. In

the short time that has elapsed since the introduction of Blister Blight to these new territories, substantial progress has been made in the understanding of the physiology of disease infection and in its control. It is now known that, contrary to the former belief, *Exobasidium vexans* does not enter by way of the stomata, but is capable of penetrating the epidermis on the upper surface, where the spores naturally fall ; and of ramifying throughout the nearly adjacent tissues, causing marked hypertrophy, till finally the basidiophores rupture the inferior epidermis and produce the typical and generally localised blister (Figure 1). Estimates of spore deposition show that only a fraction of the falling spores successfully germinate and penetrate, and that the range of eco-climate that is suitable for infection is a limited one. High temperature and sunlight are inimical, so also is a heavy film of moisture. Mist and dew, on the other hand, are ideal for causing heavy infection. The basidiospores are wind-borne in countless numbers and their viability is short-lived. The conidial stage originally described from pickled material by Massee does not, in fact, exist.

The vulnerable tissues are the young ones, *i.e.* the flush that is gathered as crop, and the succulent young growth after the pruning operation. The peak attacks occur under monsoonal conditions. At other times lie of land and shade density play an important part in determining severity of attacks, which may vary greatly within even a few hundred yards.

Because of the nature of the crop, repeated spraying with a copper fungicide is ruled out as far as tea in bearing is concerned and the most successful method of short-term control is cultural. The older fully-matured leaves are immune from infection and up-to-date practice concentrates on timing the all-important recovery from pruning to coincide with the dry weather period when infection is negligible. A secondary measure is the careful control of shade at times of special vulnerability. If, as happens in slow-growing periods, the stem of a young shoot becomes enveloped with fungus (Figure 2), the whole growing point succumbs. Continual depradations of this type tend to exhaust the elaborated foodstuffs stored in the roots upon which post-pruning development depends, and the resultant debilitation of the bush at that time may lead to death. But so long as ample mature leaf can be maintained on the bush by light pruning (which speeds up recovery from pruning and the maturation of the leaves), or by resting the bush from plucking, damage is not usually beyond hope of periodical recovery, except for bushes which are in any event debilitated already from other causes.

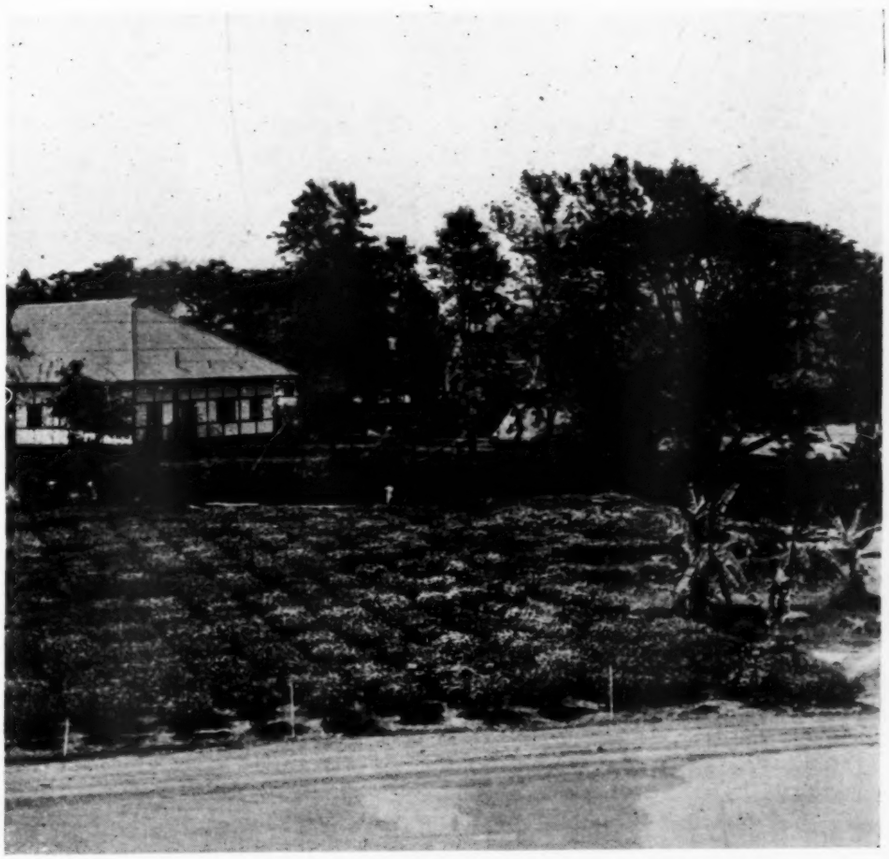
Long-term control involves selection of plants which show appreciable resistance to infection for multiplication vegetatively into resistant clones. Such plants are present already in reasonable quantities, and efforts are being made to raise material for stringent tests over a considerable variety of seasons.

It is early yet to forecast the future of this disease and its effects on the industry as a whole. The spectre of coffee rust has been constantly in people's minds. But *Hemileia vastatrix*, which wiped out coffee in Ceylon in the seventies and eighties, is capable of attacking leaves at all stages of maturity, with the result that defoliation and debilitation become progressive. Given adequate attention to cultural methods designed to maintain and renew mature foliage on the bush, there is reason to hope that a correct prognosis of the disease is that it will be a serious nuisance, but not a large-scale disaster.

Virus Disease (*Phloem Necrosis*)

In 1936 a condition of phloem necrosis was remarked in a number of bushes sent to the Ceylon Tea Research Institute for examination. Subsequent observations showed that lesions could be discovered in leaves or shoots or in the roots, and sometimes in all three. Microscopic examination of the phloem tissues is necessary for final diagnosis, but there are two helpful visual symptoms. A leaf pinched off at the petiole frequently shows a brown semicircle in the vascular tissues that is visible to the naked eye. This discoloration is due to dead phloem cells (Figure 4). In advanced stages the leaves bend back along the midrib (Figure 3), and the internodes sometimes assume a typical zigzag pattern. Leaf symptoms are most noticeable in the new growth after pruning.

In the field the distribution of the affection is patchy, and its spread is noticeable both in and across the rows. The severity of the disease increases with the altitude at which the tea is grown, and whilst at 5,000 ft. the infection doubles in about three years, above 6,000 ft. a like increase occurs in one year. Below 4,000 ft. the occurrence of the disease is rare. The method of transmission of the disease is unknown, but the standard operations of pruning and plucking are not involved, nor is the disease carried over in seed. It would appear that the vector is an organism with distinctly limited mobility. The circumstance that in experimental work a



Toklai Tea Research Station, showing well-plucked tea in the foreground

Fig. 3.—Phloem Necrosis. Typical leaf curl symptoms on young shoots which developed after pruning

period of about two years elapses between infection and onset of recognisable symptoms has added to the difficulty of isolating a vector. Confirmation of the virus nature of the disease has been derived from grafting experiments. Several techniques have been used, including inarching, seedling grafts and coupling.

The culminating trial proved that a necrotic scion could transmit the disease, through a symptomless stock, to another scion derived from a healthy but susceptible plant whose ultimate symptoms were indistinguishable from those of the first graft. In the course of these investigations it was observed that, in general, high jât bushes behaved as symptomless carriers and that low jât types were susceptible. This is of interest, because the tea at higher elevations is predominatingly of low jât. The distinction between high and low jât is not varietal and is commonly associated with size and shape of leaf. Corresponding with this observation is the fact that on trial areas in field experiments only one example of a high jât supply plant turning necrotic has been found. Roguing of necrotic plants has a beneficial effect in slowing down infection, but the main control is likely to be effected by propagating high jât symptomless carriers.

Biological control of Tea Tortrix (*Homona Coffedria*)

During the 1920s the Tea Tortrix was regarded as the most serious pest of tea in Ceylon. The moth lays her eggs in compact egg masses on the leaves and, as the larvae emerge, the leaves are damaged by feeding operations and are webbed together in preparation for pupation. Some five generations a year emerge, with maximum infestation between December and February and a minimum about June. The pest was scheduled in 1928 and the collection, enumeration and destruction of leaves bearing egg masses was made compulsory.

The introduction from Java in November 1935 and September 1936 of a larval parasite, *Macrocentrus homonae*, on to plots on which for some considerable time standardised tortrix caterpillar counts had been made was followed by significant reduction in the number of caterpillars collected, and by a great increase in parasitism due almost entirely to *Macrocentrus*. The table gives the maxima for monthly tortrix collections and for parasitism over a period of years : the two sets of data are not synchronous as regards months.

Fig. 4.—Phloem Necrosis. Transverse section of leaf petiole showing necrotic phloem

INTENSITY OF TORTRIX ATTACK AND OF PARASITISM

July to June	*Monthly Maximum (a) Tortrix Collected*	*(b) Per cent. Parasitism*
1935-6 ..	97	4
1936-7 ..	72	15
1937-8 ..	17	85
1938-9 ..	31	70
1939-40 ..	25	100
1940-1 ..	13	70

From these experimental plots the parasite has spread throughout the affected tea districts and tortrix is now effectively controlled. In 1939 Tea Tortrix was removed from the Plant Pest Schedule.

The parasite is attracted, possibly by chemotropic means, to the vicinity of the caterpillar, but otherwise works quite haphazardly in striking the tortrix with her long ovipositor (Figure 5). She lays a polyembryonic egg which may produce as many as 30 larvae in the body of the caterpillar and turn its dead body into a cocoon repository. This polyembryonic character and the dovetailing of the life-cycles of the host and parasite together account for the success of a method that has reduced tortrix to the status of an unimportant pest whose control involves no recurrent cost.

Shot-hole Borer (*Xyleborus Fornicatus*)

The Shot-hole Borer, a scoliid bark-boring beetle, cannot be controlled by biological means because the female lives most of her life in the gallery she makes and, with her brood, is securely protected. The damage done by the boring operation is of only moderate physiological importance to the bush, but cultural and plucking operations bring about many breakages through weakening of the branches at the site of the galleries. A secondary cause of damage is die-back, because the beetle often enters at a dormant bud and destroys it. By reducing the effective frame of the bush, this damage reduces crop considerably and progressively and has been observed to inhibit response to manurial treatments.

Protracted studies of beetle infestation and branch breakage have shown that the peak of infestation occurs toward the end of the second year in the pruning cycle, after which the breakages begin to decrease rapidly. Extension of the existing two-year pruning cycle to three years brought about no secondary peak and led to the first manurial response the experiment had shown during the whole 11 years of its

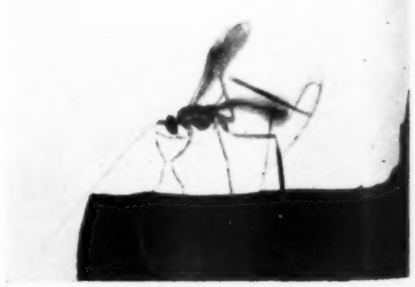


Fig. 5.—The Tortrix parasite in action. Note the long, curved ovipositor about to strike

maintenance. In the succeeding cycle (also of three years) a similar breakage pattern was observed, but at a much lower numerical level. In addition, manurial response then became evident in the second as well as the third year. It is an interesting possibility that these results were due to pruning at a time when beetle infestation was low.

This type of cultural control is a promising one and reverses a long-standing traditional pruning practice in relation to Shot-hole Borer.

Tea Yellows

The existence of a nutritional deficiency disease was reported from Nyasaland in 1933. The first symptoms are a yellow mottling of the leaves between the veins, which remain green. As the disease progresses there is a stunting of growth reflected in a reduction in the size of leaves and the length of internodes. Chlorosis becomes general and the foliage assumes a characteristic stiffness in texture, followed by a necrosis of the tissues, starting from the margins. Later on the leaves are shed and to replace them the affected bushes put out premature and abortive shoots. Defoliation is accompanied by severe die-back, and death eventually ensues.

The deficiency that causes this Tea Yellow disease has been ascribed to sulphur and the cure that is successful in the preliminary stages is the simple one of applying either elementary sulphur or, where the deficiency is slight, sulphate of ammonia to the soil. Regular manuring with artificial nitrogen is not so common in East Africa as in India and Ceylon, and as intensive manurial treatment becomes general the disease will cease to cause trouble. Similar symptoms have appeared in Tanganyika and have responded to sulphur application in the same manner. In some Kenya tea also the foliage appears very pale in comparison with that of similar jâts in India and Ceylon and it is possible that liability to this deficiency is of quite widespread occurrence in East African territories.

FOR FURTHER READING

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Agricultural Progress in INDONESIA

The Japanese invasion of Indonesia completely disrupted the internal economy of a region which, under Dutch influence, had in many ways become a pattern to the world of successful developments in tropical countries.

Since the war, despite great difficulties, much progress has been made in the restoration of production, more particularly in the Federal areas, and in some industries production is already beginning to approach the pre-war level.

BEFORE the war the Netherlands East Indies were in the aggregate the largest source of supply of a wide range of tropical products which included rubber, sugar, tea, coffee, copra and coconut oil, palm oil, spices, kapok and a number of other products. Their population exceeded 69 millions and, apart from production for export, the greater part of the food requirements required by their inhabitants was produced within their boundaries.

The invasion by the Japanese completely disrupted the internal economy, and recovery has been impeded by political unrest. Nevertheless, substantial progress has been made despite the difficulties and, in view of the importance of this region as a source of supply of many raw materials upon which the world depends, the following account of the position compiled from data supplied by the Trade Commissioner for Indonesia in London is of interest.

After the liberation from the Japanese economic recovery proceeded by stages. In the first few years it remained limited to Borneo, the eastern portion of the Archipelago, the tin islands of Banka and Billiton and a few minor areas in Java and Sumatra, but since the middle of 1947 recovery has been extended to considerable areas of Java and Sumatra previously inaccessible.

Agriculture, which economically dominates the situation, is producing quite satisfactory quantities of many products, although it is still necessary to import from abroad large quantities of rice. So far as concerns export products, the following table shows the pre-war exports of a number of the more important products for the two years prior to the Japanese invasion and for the years 1947 and 1948:

EXPORTS FROM INDONESIA IN METRIC TONS

	1940	1941	1947	1948
Rubber	282,700	335,800	13,700	280,000
Copra	N.A.	*550,000	153,000	242,000
Tea	82,000	87,400	1,500	9,400
Coffee	39,300	41,600	3,400	
Palm oil	240,000	198,300	600	39,900
Sugar	1,587,000	1,702,000	7,400	70,900

**Approximately*

The most recent information indicates that in Java, although the security position continues to be a source of anxiety, production is increasing.

Agriculture in Eastern Java . . .

By the end of June, 38 sugar plantations, 111 hill estates and 105 tobacco plantations had been returned to the owners. Ten sugar factories had started the campaign and the production is estimated at 180,000 tons of sugar. At some, work was hampered by shortage of labour and the occurrence of a particularly wet season which retarded the ripening of the cane ; one factory had to suspend activity on account of these unfavourable conditions.

The production figures of the hill estates during January/May 1949 were as follows in native tons:—

1949	*Rubber*	*Coffee*	*Tea*	*Quinine*
Jan. ..	1,344	19	19	30
Feb. ..	1,260	14	19	25
March	1,597	7	20	21
April ..	1,546	21	20	31
May ..	1,468	65	20	29
Total ..	7,217	127	98	138

During June, 3,900 bales of late crop tobacco, each weighing 100 kgs., were despatched. A start has been made with the planting of Virginia tobacco and one-third of the area intended for Virginia tobacco has already been planted. The tending of the seed beds for the late 1949

tobacco crop has been adversely affected by the west monsoon, but the arrears which resulted from this have now been made good. The leasing of fields proceeded satisfactorily.

The rice harvest in the plains had been completed by the end of June, but was still in full swing in the uplands. Good harvests of cassava and maize were, however, experienced.

. . . and in Central Java

Of a total of 152 estates, 92 had been returned to their owners by the end of June 1949. Work on the sugar plantations was carried out smoothly. An area of 9,417 hectares was planted with cane in these areas; 3,370 hectares for the 1949 campaign and 6,047 hectares for the 1950 campaign.

Work on the tobacco plantations suffered hardly any interruption. Materials are being purchased for the building of drying sheds for the forthcoming harvest.

Circumstances had an adverse effect on the development of the hill estates. The cocoa and coffee harvests, which take place mainly in the second half of the year, are at present in full swing.

The production of hill estates was as follows in native tons:—

	January 1949	*February* 1949	*March* 1949	*April* 1949	*May* 1949	*June* 1949	*Jan./June* 1949	*June/Dec.* 1948
Rubber	609.6	651.9	709.1	1,361	595.5	480.9	4,408	3,855
Quinine	5.1	8.0	5.0	8.1	7.1	5.1	38.5	40.4
Kapok	13.1	9.3	14.3	23.1	15.4	13.0	88.2	480.0
Cocoa	—	—	—	1.1	37.9	96.5	135.5	203.0
Tobacco (leaf) . .	15.9	—	—	55.7	—	—	71.6	0.8
,, (krosok)	16.1	—	—	53.7	—	—	69.8	5.7
Tea (dry) . .	5.9	5.0	8.4	9.3	10.0	10.1	48.7	18.4
Coffee	1.3	—	0.7	1.1	1.9	7.5	12.5	447.0

In Central Java 252,000 hectares are reported to have been planted under rice.

Sumatra, Celebes and Borneo

In North Sumatra operations on estates were handicapped by terrorists, but despite this were maintained. The production of rubber during the month of April was 7,000 tons. During the same period 6,300 tons of palm oil were produced and 381 tons of tea. Tea cultivation is reported to have been affected to some extent by blister blight. In Southern Sumatra economic conditions were reasonably favourable; April exports of rubber comprised 6,020 tons of slab rubber and 1,920 tons of blanket. In Eastern Indonesia exports from Celebes to other parts of Indonesia included live animals to a total value of 2.5 million florins. Padi crops were adversely affected in some areas by heavy rainfalls.

In East Borneo coconut plantations were badly neglected during the Japanese occupation and an inducement scheme has been introduced to encourage the people to clear their gardens. Replanting of pepper groves is being undertaken and nurseries are being established to supply planting material.

Coconut and copra production in Indonesia

Before the war Indonesia annually exported approximately 550,000 tons of copra together with smaller quantities of coconut oil. The bulk of the latter product is consumed locally, and before the war exports averaged only 15,000 tons. The total world exports of copra for the two pre-war years 1937 and 1938 averaged 1,135,000 tons, so that exports of copra from Indonesia formed 45% of the world total.

During the Japanese occupation coconut plantations were badly neglected, pests did a great deal of damage and numbers of palms were sacrificed by injudicious felling. The prices offered for copra were too low to induce growers to harvest their crops and, as a result, production dwindled to negligible proportions.

Since the war great efforts have been made to revive the industry and this has been reflected in steadily increasing exports, as shown by the following figures.

Post-war exports of copra

1946	54,000 tons
1947	150,227 ,,
1948	242,000 ,,

The exports are derived entirely from Federal territory and little is known of what is taking place in Republican-controlled areas. Of the pre-war exports, however, approximately four-fifths were derived from regions which were in 1948 controlled by the Federal Government.

The industry is practically entirely dependent on production from native-owned small holdings. Reliable figures for production are not obtainable, since much of the produce is used in the country itself, being either consumed direct as fresh coconuts, or used as copra for the extraction of oil in local factories, which, in addition to being largely consumed as such, is also employed for making margarine, cooking fats and soap for local consumption.

About three-fifths of the total production comes from Eastern Indonesia, notably Celebes (Macassar), and this region is markedly dependent on the crop. Of the total exports in 1948, 216,000 tons were derived from Eastern Indonesia, 17,500 tons from Borneo and the remaining 8,500 tons from other districts.

Measures for rehabilitation

Prior to the Japanese invasion an organisation was founded to look after the interests of the copra industry, known as '*Het Coprafonds*.' Since the war this organisation has been restarted with the object of reviving production and export of copra. Stocks were insignificant and the organisation concentrated principally on stimulation of production, providing information about prices, building and repairing godowns, providing credits for the rehabilitation of coconut plantations and purchasing or advancing money against the crop.

As a result of its activities production has been considerably stimulated and some regions are already producing more copra than they were before the war.

Coconut oil manufacture

Many of the coconut oil factories were severely damaged during the Japanese occupation and required extensive repairs and replacements before they could again be brought into effective operation. Much repair work and reconditioning has been done but production is limited by supplies of copra, owing to the emphasis which has been laid on the need for exporting as much copra as possible. In order to meet local demands for oils and fats arrangements have now been made through the Copra Fund whereby monthly deliveries of copra to the factories up to 4,500 tons have been guaranteed, but this falls far short of the potential capacity which before the war was about 40,000 tons per month of which, however, the whole was not utilised. The present capacity is estimated to be roughly 15,000 tons per month.

The aim is steadily to increase exports while at the same time providing for the needs of the local population for oils and fats. It is anticipated that for the year 1949/50 exports of copra will reach 400,000 tons while for 1951/52 the export target has been set at 600,000 tons in addition to providing fully for local requirements. If this expectation is realised Indonesia will once more have resumed the commanding position in the copra trade which it occupied in pre-war days.

India's Sugar Industry

DURING the last seventeen years the rapid growth of the sugar industry in India has made her one of the largest sugar producing countries in the world. Today this industry has become a vital part of the country's economy and it ranks as the second largest in India. How spectacular this growth has been can be assessed by the fact that whereas in 1931-32 her imports of sugar totalled to 514,475 tons as against an indigenous factory production of 158,781 tons, by 1946-47 imports practically ceased while indigenous production was about 1,000,000 tons.

Progress of the industry

The remarkable progress made by the sugar industry has been mainly due to the tariff protection given to it by the Government of India. The following table shows the progress made by the industry since 1932 when protection was first granted.

Year (Nov.-Oct.).	*No. of Cane Factories working in India.*	*Total Production of Sugar in India (Nov.-Oct.). Tons*
1931-32	32	471,000
1932-33	57	645,000
1933-34	112	718,900
1934-35	130	771,600
1935-36	137	1,105,000
1936-37	137	1,237,000
1937-38	136	1,072,900
1938-39	139	762,500
1939-40	145	1,393,200
1940-41	148	1,340,100
1941-42	150	898,500
1942-43	150	1,292,500
1943-44	151	1,374,000
1944-45	140	1,084,900
1945-46	145	1,065,800
1946-47	140	1,010,100
1947-48	134	1,176,800
1948-49	134	1,100,000

Source : The Indian Sugar Industry—(1947-48 Annual).

The area under sugarcane has also rapidly expanded. In 1930-31 the acreage under this crop was 2.9 million acres whereas today it is 3½ million acres. This comes to above 2% of the cultivated area in India and represents approximately 35% of the world's sugarcane area.

At present there are 135 working sugar mills and accounting for an investment of capital to the extent of about £27 million.

The majority of the factories produce sugar by the sulphitation process and only 17 by the carbonation process.

The sugar industry is one of the most efficient industries in India and the credit for this mainly goes to the Central Sugarcane Committee which since its inception in 1944 has endeavoured to apply modern methods of scientific planning and research to this industry.

Indian Central Sugarcane Committee

The Committee was formed under the auspices of the Indian Council of Agricultural Research for the direction and promotion of sugarcane research and to advise Central and Provincial Governments in matters regarding the undertaking of development and improvement of the growing, marketing, and manufacture of sugarcane and its products, and initiation of agricultural, technological, and economic research on sugarcane production and distribution and testing of improved varieties of cane, gur, sugar and their by-products, the improvement of crop forecasts, and statistics, as well as the adoption of improved cultural and manurial practice. In due course, it is also expected to deal with the important problem of banking and transport facilities connected with cane and sugar. In other words, all questions germane to sugar come within the ambit of this Committee.

The results of the efforts of the Committee can be seen both from the fact that out of the total area grown this year 85% is under improved varieties as against 77.4% in 1940-41 and that production, after experiencing a fall from 1.2 million tons in 1943-44 to 0.9 million tons in 1944-45, has gone up to 1.07 million tons. The normal capacity of the Indian sugar mills is about 1.08 million tons per annum, which can be raised to 1.4 million tons by quicker transport, better cane, and greater manufacturing efficiency.

Protection for the industry

In spite of these achievements the Committee has expressed the opinion that 'the sugar industry in India is not yet in a position to compete on equal terms with imported sugar and that, since the basic improvements in the agricultural sphere must necessarily take time, protection to the industry must continue for at least another few years.' The protection given to the sugar industry is due to expire on March 31, 1950, and the Government of India have decided that the Tariff Board should undertake a detailed enquiry into the circumstances.

India may be said to have nearly reached self-sufficiency in sugar at the present rate of consumption: but this compared with *per capita* consumption in other countries is very low. A citizen of Cuba consumes on an average 88 lb. of sugar per year, of the U.S.A. 97 lb., of the U.K. 106 lb., of Australia 160 lb., and of India 26 lb. Based on a consumption of at least 2 oz. per day as a part of a well balanced diet a citizen of India would need about 46 lb. of sugar per year. This would mean that the present production has to be at least doubled and has to be accompanied by reduction in the cost of production.

With this in view in September 1948 the Government of India fixed the target for sugar production within the next five years at 1.8 million tons, sanctioned 40 additional units and permitted the existing factories to increase their capacity within prescribed limits.

Production costs

Regarding cost of production, the dual and vital necessity of increasing yield of cane per acre on the one hand and enhancing the efficiency of the production units on the other are fully appreciated.

The Government of India have earmarked a sum of £375,000 for the establishment of an Institute of Sugar Technology and Sugarcane Research. The site selected is Bhadruk Farm, in close vicinity to Lucknow, United Provinces.

All aspects of the industry including breeding, agronomy, chemistry, physiology, study and control of pests and diseases and all problems connected with sugar technology will be brought under the direct supervision and regulation of the Central Sugarcane Committee.

Technical committee

In July last the Government appointed a Technical Committee, to enquire into the cost of production of sugarcane in different parts of the country, to review the progress of cane research and development and suggest ways and means for increasing the yield of sugarcane per acre and the sugar contents of cane, with a view to reducing the cost of production of sugar.

Acknowledgment

The photograph which appeared on page 82 of our October issue was reproduced by courtesy of Pest Control Ltd. We regret that we omitted to mention this fact.

WORLD CROP REPORTS

Italian Citrus Fruit Exports

Total exports of oranges and mandarines from Italy in the 1948-49 season (October to June) amounted to 190,000 tons (gross weight), of which the United Kingdom received 33,000 tons, Switzerland 34,000 tons, Germany 28,000 tons, Austria 25,000 tons and Belgium 20,000 tons. Exports of lemons from Italy in the same period were 153,000 tons, of which the United Kingdom took 35,000 tons and Germany 32,000 tons.

EXPORTS OF CITRUS FRUIT FROM ITALY, 1948-49 SEASON

	Oranges	*Mandarines*	*Lemons*	*Total*
MONTHLY TOTALS:		*Tons (gross weight)*		
October 1948	27	—	17,221	17,248
November	3,467	7,423	16,475	27,365
December	29,741	17,375	12,205	59,321
January 1949	30,026	13,196	18,029	61,251
February	25,974	3,167	14,767	43,908
March	31,045	1,231	14,667	46,943
April	17,684	28	22,349	40,061
May	7,470	—	13,100	20,570
June	1,897	—	24,631	26,528
Total ..	147,331	42,420	153,444	343,195
COUNTRIES OF DESTINATION:				
United Kingdom ..	1,855	30,654	35,111	67,620
Germany	27,004	1,280	31,771	60,055
Switzerland	30,392	3,300	4,262	37,954
Austria	23,792	802	10,881	35,475
Belgium	14,871	4,641	8,211	27,723
France	5,920	93	19,740	25,753
Other European ..	43,255	1,646	26,202	71,103
Canada	178	—	11,095	11,273
United States	—	—	5,735	5,735
Other non-European ..	64	4	436	504
Total ..	147,331	42,420	153,444	343,195

Pakistan Cotton

The fourth (final) forecast of the area under cotton for the year 1948-49 is 2,715,000 acres as against 3,122,000 acres reported in the fourth (final) forecast of the previous year, and shows a decrease of 13%.

There was a general decrease in the acreage throughout Pakistan, which is attributed to unfavourable weather conditions. The area under American varieties decreased by 14% from 2,629,000 acres to 2,262,000 acres and that under Desi varieties by 8.1% from 493,000 acres to 453,000 acres.

The fourth (final) forecast of the yield of this crop is 980,000 bales of 400 lbs. each as against 1,115,000 bales reported in the previous year's forecast and shows a fall of 12.1%. Except in East Bengal, there was a general decrease in the yield of this crop throughout Pakistan, which is attributed to unfavourable weather conditions. The out-turn under American varieties decreased by 12.9% from 949,000 bales to 827,000 bales and that under Desi varieties decreased by 7.8% from 166,000 bales to 153,000 bales. In certain parts of West Punjab and Bahawalpur State the crop was damaged by frost. Besides, the premature opening of the balls of American varieties also resulted in decreased outturn.

U.S. Cotton Crop

A 1949 U.S. cotton crop considerably larger than expected market demands is indicated in a forecast by the U.S. Department of Agriculture.

In a revised estimate of this year's cotton production, the Agriculture Department announced on September 8 that it expects a crop of 14,943,000 bales of 500 lbs. gross weight each. This is 138,000 bales more than the Department's August 1 forecast and 75,000 bales more than last year's production.

Cotton production in 1948 was 14,868,000 bales and the 1938-1947 average yield was 11,306,000 bales.

The 1949 crop will be augmented by a carry-over of 5,600,000 bales from previous crops.

Wattle Industry for Tanganyika

The British Colonial Development Corporation has decided to take up wattle planting and the extraction of tannin in Tanganyika's southern highlands. The district chosen is the windy grassland of the 6,000 ft.-high Njombe district, where a beginning was made last year with a similar scheme under private enterprise. The East African Tanning Extract Co., which operates in similar but less remote country in Kenya, had already ploughed 700 acres of a planned 30,000 acreage when its £1,000,000 scheme was dropped owing to financing difficulties. This company had proposed to erect the tannin extraction plant at Njombe.

It is understood that the new project is bigger than last year's private one.

Africans interested in wattle planting already in a small way on the ground ploughed for last year's abortive scheme will be employed on the new scheme.

In 1948 a total of £43,000 sterling worth of bark for tanning was exported from Tanganyika. The new scheme provides for extraction of the tannin on the spot.

Production of Plums and Prunes

The indicated world production of plums and prunes for all purposes for 1949 is estimated to be 2.7 million short tons, 11% higher than the 2.4 produced during the preceding year and 5% below the pre-war average of 2.8 million. Production in the North American area, estimated at 709,400 tons, compares with 635,875 for 1948 and 808,731 for the pre-war average (1935-39). Of the total of 709,400 tons for 1949, the United States has an indicated production of 685,800, consisting of 96,400 tons of plums, and 589,400 prunes.

South African Sugar Production

The official estimate of sugar production in South Africa for 1949 has been reduced to 608,650 short tons but the reduction is unimportant in view of the large carry over of 81,000 short tons from last season's output.

Estimated consumption in the Union is approximately 561,000 short tons. Exports are anticipated at 20,000 tons to Southern Rhodesia and about 50,000 tons to the United Kingdom.